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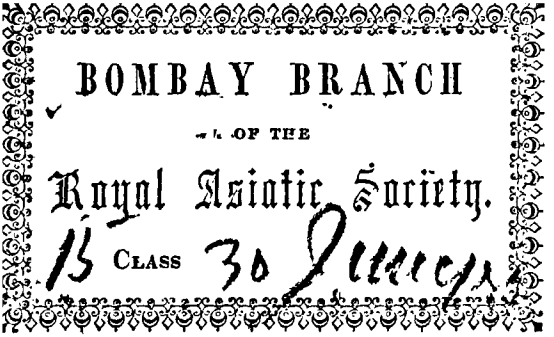

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NOTES

ON

RAILROAD ACCIDENTS

BY

93888

CHARLES FRANCIS ADAMS, J.

AUTHOR OF "RAILROADS: THEIR ORIGIN AND PROBLEMS."

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PREFACE.

This volume makes no pretence whatever of being either an exhaustive or a scientific study of the subject to which it relates. It is, on the contrary, merely what its title signifies,—a collection of notes on railroad accidents. In the course of ten years service as one of the railroad commissioners of Massachusetts, I was called upon officially to investigate two very serious disasters,—that at Revere in 1871, and that at Wollaston in 1878,—besides many others less memorable. In connection with these official duties I got together by degrees a considerable body of information, which I was obliged to extract as best I could from newspapers and other contemporaneous sources. I have felt the utmost hesitation in publishing so crude and imperfect a performance, but finally decide to do so for the reason that, so far as I know, there is nothing relating to this subject in print in an accessible form, and it would, therefore, seem that these notes may have a temporary value.

During my term of public service, also, there have been four appliances, either introduced into use or now struggling for American recognition, my sense of the value of

which, in connection with the railroad system, to both the traveling and general public, I could not easily overstate. These appliances are the MILLER PLATFORM and BUFFER, the WESTINGHOUSE BRAKE, and the INTERLOCKING and ELECTRIC SIGNAL SYSTEMS. To bring these into more general use through reports on railroad accidents as they occurred was one great aim with me thoughout my official life. I am now not without hopes that the printing of this volume may tend to still further familiarize the public with these inventions, and thus hasten their more general adoption.

C. F. A. JR.

Quincy, October 1, 1879.

NOTES

ON

RAILROAD ACCIDENTS.

IT is a melancholy fact that there are few things of which either nature or man is, as a rule, more lavish than human life;—provided always that the methods used in extinguishing it are customary and not unduly obtrusive on the sight and nerves. As a necessary consequence of this wastefulness, it follows also that the results which ordinarily flow from the extinguishment of the individual life are pitiably small. Any person curious to satisfy himself as to the truth of either or both of these propositions can do so easily enough by visiting those frequent haunts in which poverty and typhoid lurk in company; or yet more easily by a careful study of the weekly bills of mortality of any great city. Indeed, compared with the massive battalions daily sacrificed in the perpetual conflict which mankind seems forever doomed to wage against intemperance, bad sewerage and worse ventilation, the victims of regular warfare by sea and land count as but single spies. The worst of it is, too, that if the blood of the martyrs thus profusely spilled is at all the seed of

the church, it is a seed terribly slow of germination. Each step in the slow progress is a Golgotha.

In the case of railroad disasters, however, a striking exception is afforded to this rule. The victims of these, at least, do not lose their lives without great and immediate compensating benefits to mankind. After each new "horror," as it is called, the whole world travels with an appreciable increase of safety. Both by public opinion and the courts of law the companies are held to a most rigid responsibility. The causes which led to the disaster are anxiously investigated by ingenious men, new appliances are invented, new precautions are imposed, a greater and more watchful care is inculcated. And hence it has resulted that each year, and in obvious consequence of each fresh catastrophe, travel by rail has become safer and safer, until it has been said, and with no inconsiderable degree of truth too, that the very safest place into which a man can put himself is the inside of a first-class railroad carriage on a train in full motion.

The study of railroad accidents is, therefore, the furthest possible from being a useless one, and a record of them is hardly less instructive than interesting. If carried too far it is apt, as matter for light reading, to become somewhat monotonous; though, none the less, about these, as about everything else, there is an almost endless variety. Even in the forms of sudden death on the rail, nature seems to take a grim delight in an infinitude of surprises.

CHAPTER I.

THE DEATH OF MR. HUSKISSON.

WITH a true dramatic propriety, the ghastly record, which has since grown so long, began with the opening of the first railroad,—literally on the very morning which finally ushered the great system into existence as a successfully accomplished fact, the eventful 15th of September, 1830, —the day upon which the Manchester & Liverpool railroad was formally opened. That opening was a great affair. A brilliant party, consisting of the directors of the new enterprise and their invited guests, was to pass over the road from Liverpool to Manchester, dine at the latter place and return to Liverpool in the afternoon. Their number was large and they filled eight trains of carriages, drawn by as many locomotives. The Duke of Wellington, then prime minister, was the most prominent personage there, and he with his party occupied the state car, which was drawn by the lo-

comotive *Northumbrian*, upon which George Stephenson himself that day officiated as engineer. The road was laid with double tracks, and the eight trains proceeded in two parallel columns, running side by side and then again passing or falling behind each other. The Duke's train gaily led the race, while in a car of one of the succeeding trains was Mr. William Huskisson, then a member of Parliament for Liverpool and eminent among the more prominent public men of the day as a financier and economist. He had been very active in promoting the construction of the Manchester & Liverpool road, and now that it was completed he had exerted himself greatly to make its opening a success worthy an enterprise the far-reaching consequences of which he was among the few to appreciate. All the trains had started promptly from Liverpool, and had proceeded through a continued ovation until at eleven o'clock they had reached Parkside, seventeen miles upon their journey, where it had been arranged that the locomotives were to replenish their supplies of water. As soon as the trains had stopped, disregarding every caution against their so doing, the excited and joyous passengers left their carriages and mingled together, eagerly congratulating one another upon the unalloyed success of the occasion. Mr. Huskisson, though in poor health and somewhat lame, was one of the most excited of the throng, and among the first to thus expose himself. Presently he caught the eye of the Duke of Welling-

ton, standing at the door of his carriage. Now it so happened that for some time previous a coolness had existed between the two public men, the Duke having as premier, with the military curtness for which he was famed, dismissed Mr. Huskisson from the cabinet of which he had been a member, without, as was generally considered, any sufficient cause, and in much the same way that he might have sent to the right-about some member of his staff whose performance of his duty was not satisfactory to him. There had in fact been a most noticeable absence of courtesy in that ministerial crisis. The two now met face to face for the first time since the breach between them had taken place, and the Duke's manner evinced a disposition to be conciliatory, which was by no means usual with that austere soldier. Mr. Huskisson at once responded to the overture, and, going up to the door of the state carriage, he and his former chief shook hands and then entered into conversation. As they were talking, the Duke seated in his car and Mr. Huskisson standing between the tracks, the *Rocket* locomotive—the same famous *Rocket* which a year previous had won the five hundred pounds prize, and by so doing established forever the feasibility of rapid steam locomotion—came along upon the other track to take its place at the watering station. It came up slowly and so silently that its approach was hardly noticed; until, suddenly, an alarm was given, and, as every one immediately ran to resume his place, some com-

motion naturally ensued. In addition to being lame, Mr. Huskisson seemed also under these circumstances to be quite agitated, and, instead of quietly standing against the side of the carriage and allowing the *Rocket* to pass, he nervously tried to get around the open carriage door, which was swinging out across the space between the two tracks in such a way that the approaching locomotive struck it, flinging it back and at the same time throwing Mr. Huskisson down. He fell on his face in the open space between the tracks, but with his left leg over the inner of the two rails upon which the *Rocket* was moving, so that one of its wheels ran obliquely up the limb to the thigh, crushing it shockingly. As if to render the distressing circumstances of the catastrophe complete, it so happened that the unfortunate man had left his wife's side when he got out of his carriage, and now he had been flung down before her eyes as he sought to reënter it. He was immediately raised, but he knew that his hurt was mortal and his first exclamation was, "I have met my death!" He was at once placed on one of the state carriages, to which the *Northumbrian* locomotive was attached, and in twenty-five minutes was carried to Eccles, a distance of seventeen miles, where medical assistance was obtained. He was far beyond its reach, however, and upon the evening of the same day, before his companions of the morning had completed their journey, he was dead. Some time after this accident a great public

dinner was given at Liverpool in honor of the new enterprise. Brougham was then at the height of an unbounded popularity and just taking the fatal step of his life, which led him out of the House of Commons to the wool-sack and the Lords. Among the excursionists of the opening day he had on the 16th, occasion to write a brief note to Macvey Napier, editor of the *Edinburgh Review*, in which he thus alluded to the fatal accident which had marred its pleasure:—"I have come to Liverpool only to see a tragedy. Poor Huskisson is dead, or must die before to-morrow. He has been killed by a steam carriage. The folly of seven hundred people going fifteen miles an hour, in six carriages, exceeds belief. But they have paid a dear price." He was one of the guests at the subsequent dinner, and made a speech in which there was one passage of such exquisite oratorical skill, that to read it is still a pleasure. In it he at once referred to the wonders of the system just inaugurated, and to the catastrophe which had saddened its opening observances. "When," he said, "I saw the difficulties of space, as it were, overcome; when I beheld a kind of miracle exhibited before my astonished eyes; when I saw the rocks excavated and the gigantic power of man penetrating through miles of the solid mass, and gaining a great, a lasting, an almost perennial conquest over the powers of nature by his skill and industry; when I contemplated all this, was it possible for me to avoid the reflections which crowded

into my mind, not in praise of man's great success, not in admiration of the genius and perseverance he had displayed, or even of the courage he had shown in setting himself against the obstacles that matter afforded to his course—no! but the melancholy reflection, that these prodigious efforts of the human race, so fruitful of praise but so much more fruitful of lasting blessings to mankind, have forced a tear from my eye by that unhappy casualty which deprived me of a friend and you of a representative!"

Though wholly attributable to his own carelessness, the death of so prominent a character as Mr. Huskisson, on such an occasion, could not but make a deep impression on the public mind. The fact that the dying man was carried seventeen miles in twenty-five minutes in search of rest and medical aid, served rather to stimulate the vague apprehension which thereafter for a time associated itself with the new means of transportation, and converted it into a dangerous method of carriage which called for no inconsiderable display of nerve on the part of those using it. Indeed, as respects the safety of travel by rail there is an edifying similarity between the impressions which prevailed in England forty-five years ago and those which prevail in China now; for, when as recently as 1875 it was proposed to introduce railroads into the Celestial Empire, a vigorous native protest was fulminated against them, in which, among other things scarcely less astounding,

it was alleged that "in all countries where railroads exist they are considered a very dangerous mode of locomotion, and, beyond those who have very urgent business to transact, no one thinks of using them."

On this subject, however, of the dangers incident to journeys by rail, a writer of nearly half a century back, who has left us one of the earliest descriptions of the Manchester & Liverpool road, thus reassured the public of those days, with a fresh quaintness of style which lends a present value to his words: "The occurrence of accidents is not so frequent as might be imagined, as the great weight of the carriages" (they weighed about one-tenth part as much as those now in use in America) "prevents them from easily starting off the rails; and so great is the momentum acquired by these heavy loads moving with such rapidity, that they easily pass over considerable obstacles. Even in those melancholy accidents where loss of life has been sustained, the bodies of the unfortunate sufferers, though run over by the wheels, have caused little irregularity in the motion, and the passengers in the carriages have not been sensible that any impediment has been encountered on the road."

Indeed, from the time of Mr. Huskisson's death, during a period of over eleven years, railroads enjoyed a remarkable and most fortunate exemption from accidents. During all that time there did not occur a single disaster resulting in any considerable loss of life; an immunity which seems to have been

due to a variety of causes. Those early roads were, in the first place, remarkably well and thoroughly built, and were very cautiously operated under a light volume of traffic. The precautions then taken and the appliances in use would, it is true, strike the modern railroad superintendent as both primitive and comical; for instance, they involved the running of independent pilot locomotives in advance of all night passenger trains. Through all the years between 1830 and 1841, nevertheless, not a single really serious railroad disaster had to be recorded. This happy exemption was, however, quite as much due to good fortune as to anything else, as was well illustrated in the first accident at all serious in its character, which occurred,—an accident in its every circumstance, except loss of life, almost an exact parallel to the famous Revere disaster which happened nearly forty years later in Massachusetts. It chanced on the Manchester & Liverpool Railway on December 23, 1832. The second-class morning train had stopped at the Rainhill station to take in passengers, when those upon it heard through the dense fog another train, which had left Manchester forty-five minutes later, coming towards them at a high rate of speed. When it first became visible it was but one hundred and fifty yards off, and a collision was inevitable. Those in charge of the stationary train, however, succeeded in getting it under a slight headway, and in so much diminished the shock of the collision; but, notwithstanding, the last five carriages were injured, the one at the end being totally

demolished. Though quite a number of the passengers were cut and bruised, and several were severely hurt, one only, strange to say, was killed.

Indeed, the luck—for it was nothing else—of those earlier times was truly amazing. Thus on this same Manchester & Liverpool road, as a first-class train on the morning of April 17, 1836, was moving at a speed of some thirty miles an hour, an axle broke under the first passenger coach, causing the whole train to leave the track and throwing it down the embankment, which at that point was twenty feet high. The cars were rolled over, and the passengers in them tumbled about topsy-turvey; nor, as they were securely locked in, could they even extricate themselves when at last the wreck of the train reached firm bearings. And yet no one was killed. Here the corporation was saved by one chance in a thousand, and its almost miraculous good fortune has since received numerous and terrible illustrations. Among these two are worthy of a more than passing mention. They happened one in America and one in England, though with some interval of time between them, and are curious as illustrating very forcibly the peculiar dangers to which those travelling by rail in the two countries are subjected under almost precisely similar circumstances. The American accident referred to was that popularly known on account of its exceptionally harrowing details as the "Angola horror," of December 18, 1867, while the English accident was that which occurred at Shipton-on-Cherwell on December 24, 1874.

CHAPTER II.

THE ANGOLA AND SHIPTON ACCIDENTS.

On the day of the Angola accident the eastern bound express train over the Lake Shore road, as it was then called, consisted of a locomotive, four baggage, express and mail cars, an emigrant and three first-class passenger coaches. It was timed to pass Angola, a small way station in the extreme western part of New York, at 1.30 P.M., without stopping; but on the day in question it was two hours and forty-five minutes late, and was consequently running rapidly. A third of a mile east of the station there is a shallow stream, known as Big Sister creek, flowing in the bottom of a ravine the western side of which rises abruptly to the level of the track, while on the eastern side there is a gradual ascent of some forty or fifty rods. This ravine was spanned by a deck bridge of 160 feet in length, at the east end of which was an abutment of mason work some fifty feet long connecting with

an embankment beyond. It subsequently appeared that the forward axle in the rear truck of the rear car was slightly bent. The defect was not perceptible to the eye, but in turning round the space between the flanges of the wheels of that axle varied by three-fourths of an inch. As long as the car was travelling on an unbroken track, or as long as the wheels did not strike any break in the track at their narrowest point, this slight bend in the axle was of no consequence. There was a frog in the track, however, at a distance of 600 feet east of the Angola station, and it so happened that a wheel of the defective axle struck this frog in such a way as to make it jump the track. The rear car was instantly derailed. From the frog to the bridge was some 1200 feet. With the appliances then in use the train could not be stopped in this space, and the car was dragged along over the ties, swaying violently from side to side. Just before the bridge was reached the car next to the last was also thrown from the track, and in this way, and still moving at considerable speed, the train went onto the bridge. It was nearly across when the last car toppled off and fell on the north side close to the abutment. The car next to the rear, more fortunate, was dragged some 270 feet further, so that when it broke loose it simply slid some thirty feet down the embankment. Though this car was badly wrecked, but a single person in it was killed. His death was a very singular one. Before the car

separated from the train, its roof broke in two transversely; through the fissure thus made this unfortunate passenger was partly flung, and it then instantly closed upon him.

The other car had fallen fifty feet, and remained resting on its side against the abutment with one end inclined sharply downward. It was mid-winter and cold, and, as was the custom then, the car was heated by two iron stoves, placed one at each end, in which wood was burned. It was nearly full of passengers. Naturally they all sprang from their seats in terror and confusion as their car left the rails, so that when it fell from the bridge and violently struck on one of its ends, they were precipitated in an inextricable mass upon one of the overturned stoves, while the other fell upon them from above. A position more horrible could hardly be imagined. Few, if any, were probably killed outright. Some probably were suffocated; the greatest number were undoubtedly burned to death. Of those in that car three only escaped; forty-one are supposed to have perished.

This was a case of derailment aggravated by fire. It is safe to say that with the improved appliances since brought into use, it would be most unlikely to now occur under precisely the same circumstances on any well-equipped or carefully operated road. Derailments, of course, by broken axles or wheels are always possible, but the catastrophe at Angola was primarily due to the utter inability of those on

the train to stop it, or even greatly to check its speed within any reasonable distance. Before it finally stood still the locomotive was half a mile from the frog and 1,500 feet from the bridge. Thus, when the rear cars were off the track, the speed and distance they were dragged gave them a lateral and violently swinging motion, which led to the final result. Though under simila rcircumstances now this might not happen, there is no reason why, circumstances being varied a little, the country should not again during any winter day be shocked by another Angola sacrifice. Certainly, so far as the danger from fire is concerned, it is an alarming fact that it is hardly less in 1879 than it was in 1867. This accumulative horror is, too, one of the distinctive features of American railroad accidents. In other countries holocausts like those at Versailles in 1842 and at Abergele in 1868 have from time to time taken place. They are, however, occasioned in other ways, and, as their occurrence is not regularly challenged by the most risky possible of interior heating apparatus, are comparatively infrequent. The passenger coaches used on this side of the Atlantic, with their light wood-work heavily covered with paint and varnish, are at best but tinder-boxes. The presence in them of stoves, hardly fastened to the floor and filled with burning wood and coal, involves a degree of risk which no one would believe ever could willingly be incurred, but for the fact that it is. No invention yet appears to have wholly met the requirements of

the case. That they will be met, and the fearful possibility which now hangs over the head of every traveller by rail, that he may suddenly find himself doomed without possibility of escape to be roasted alive, will be at least greatly reduced hardly admits of question.

Turning now from the American to the English accident, it is singular to note how under very similar circumstances much the same fatality resulted from wholly different causes. It happened on the day immediately preceding Christmas, and every train which at that holiday season leaves London is densely packed, for all England seems then to gather away from its cities to the country hearths. Accordingly, the ten o'clock London express on the Great Western Railway, when it left Oxford that morning, was made up of no less than fifteen passenger carriages and baggage vans, drawn by two powerful locomotives and containing nearly three hundred passengers. About seven miles north of Oxford, as the train, moving at a speed of some thirty to forty miles an hour, was rounding a gentle curve in the approach to the bridge over the little river Cherwell, the tire of one of the wheels of the passenger coach next behind the locomotive broke, throwing it off the track. For a short distance it was dragged along in its place; but almost immediately those in charge of the locomotives noticed that someting was wrong, and, most naturally and with the very best of intensions, they instantly did the very worst thing

which under the circumstances it was in their power to do,—they applied their brakes and reversed their engines; their single thought was to stop the train. With the train equipped as it was, however, had these men, instead of crowding on their brakes and reversing their engines, simply shut off their steam and by a gentle application of the brakes checked the speed gradually and so as to avoid any strain on the couplings, the carriages would probably have held together and remained upon the road-bed. Instead of this, however, the sudden checking of the two ponderous locomotives converted them into an anvil, as it were, upon which the unfortunate leading carriage already off the rails was crushed under the weight and impetus of those behind it. The train instantly zig-zagged in every direction under the pressure, the couplings which connected it together snapping, and the carriages, after leaving the rails to the right and left and running down the embankment of about thirteen feet in height, came to a stand-still at last, several of them in the reverse order from that which they had held while in the train. The first carriage was run over and completely destroyed; the five rear ones were left alone upon the road-bed, and of these two only were on the rails; of the ten which went down the embankment, two were demolished. In this disaster thirty-four passengers lost their lives, and sixty-five others, besides four employés of the company, were injured.

At the time it occurred the Shipton accident was

the subject of a good deal of discussion, and both the brake system and method of car construction in use on English roads were sharply criticised. It was argued, and apparently with much reason, that had the "locomotives and cars been equipped with the continuous train-brakes so generally in use in America, the action of the engine drivers would have checked at the same instant the speed of each particular car, and probably any serious accident would have been averted." Yet it required another disaster, not so fatal as that at Shipton-on-Cherwell but yet sufficiently so, to demonstrate that this was true only in a limited degree,—to further illustrate and enforce the apparently obvious principle that, no matter how heavy the construction may be, or what train-brake is in use, to insure safety the proportion between the resisting strength of car construction and the train-weight momentum to which it may be subjected must be carefully preserved.

On this point of the resisting power of modern car construction, indeed, it seemed as if a result had been reached which did away with the danger of longitudinal crushing. Between 1873 and 1878 a series of accidents had occurred on the American roads of which little was heard at the time for the simple reason that they involved no loss of life,—they belonged in the great category of possible disasters which might have happened, had they not been prevented. Trains going in opposite directions and at full speed had come in collision

while rounding curves; trains had run into earth-slides, and had been suddenly stopped by derailment; in every such case, however, the Westinghouse brake and the Miller car construction had, when in use, proved equal to the emergency and the passengers on the trains had escaped uninjured. The American mechanic had accordingly grown firm in his belief that, so far as any danger from the crushing of cars was concerned,—unless indeed they were violently thrown down an embankment or precipitated into an abyss,—the necessary resisting strength had been secured and the problem practically solved. That such was not the case in America in 1878 any more than in England in 1875, except within certrin somewhat narrow limits, was unexpectedly proven by a disaster which occurred at Wollaston near Boston, on the Old Colony road, upon the evening of October 8, 1878.

CHAPTER III.

THE WOLLASTON ACCIDENT.

A LARGE party of excursionists were returning from a rowing match on a special train consisting of two locomotives and twenty-one cars. There had been great delay in getting ready for the return, so that when it neared Wollaston the special was much behind the time assigned for it. Meanwhile a regular freight train had left Boston, going south and occupying the outward track. At Wollaston those in charge of this train had occasion to stop for the purpose of taking up some empty freight cars, which were standing on a siding at that place; and to reach this siding it was necessary for them to cross the inward track, temporarily disconnecting it. The freight train happened to be short-handed, and both its conductor and engineer supposed that the special had reached Boston before they had started out. Accordingly, in direct violation of the rules of the road and with a negligence which ad-

mitted of no excuse, they disconnected the inward track in both directions and proceeded to occupy it in the work of shunting, without sending out any signals or taking any precautions to protect themselves or any incoming train. It was after dark, and, though the switches were supplied with danger signals, these were obscured by the glare of the locomotive head-light. Under these circumstances the special neared the spot. What ensued was a curious illustration of those narrow escapes through which, by means of improved appliances or by good luck, railroad accidents do not happen; and an equally curious illustration of those trifling derangements which now and again bring them about. In this case there was no collision, though a freight-train was occupying the inward track in front of the special. There should have been no derailment, though the track was broken at two points. There would have been no accident, had there been no attempt made to avert one. Seeing the head-light of the approaching special, while yet it was half a mile off, the engineer of the freight train realizing the danger had put on all steam, and succeeded, though by a very narrow margin, in getting his locomotive and all the cars attached to it off of the inward track and onto the outward, out of the way of the special. The inward track was thus clear, though broken at two points. The switches at those points were, however, of the safety pattern, and, if they were left alone and did their work, the special would

simply leave the main track and pass into the siding, and there be stopped. Unfortunately the switches were not left alone. The conductor of the freight train had caught sight of the head-light of the approaching locomotive at about the same time as the engineer of that train. He seems at once to have realized the possible consequences of his reckless neglect of precautions, and his one thought was to do something to avert the impending disaster. In a sort of dazed condition, he sprang from the freight car on which he was standing and ran to the lever of the siding switch, which he hastened to throw. He apparently did not have time enough within perhaps five seconds. Had he succeeded in throwing it, the train would have gone on to Boston, those upon it simply knowing from the jar they had received in passing over the first frog that a switch had been set wrong. Had he left it alone, the special would have passed into the siding and there been stopped. As it was, the locomotive of the special struck the castings of the switch just when it was half thrown—at the second when it was set neither the one way nor the other—and the wreck followed. It was literally the turning of a hand.

As it approached the point where the disaster occurred the special train was running at a moderate rate of speed, not probably exceeding twenty miles an hour. The engineer of its leading locomotive also perceived his danger in time to signal it and to reverse his engine while yet 700 feet from the point where

derailment took place. The train-brake was necessarily under the control of the engineer of the second locomotive, but the danger signal was immediately obeyed by him, his locomotive reversed and the brake applied. The train was, however, equipped with the ordinary Westinghouse, and not the improved automatic or self-acting brake of that name. That is, it depended for its efficiency on the perfectness of its parts, and, in case the connecting tubes were broken or the valves deranged, the brake-blocks did not close upon the wheels, as they do under the later improvements made by Westinghouse in his patents, but at best remained only partially set, or in such positions as they were when the parts of the brake were broken. As is perfectly well understood, the original Westinghouse does not work quickly or effectively through more than a certain number of cars. Twelve is generally regarded as the limit of practical simultaneous action. The 700 feet of interval between the point where the brakes were applied and that where the accident occurred,—a distance which, at the rate at which the train was moving, it could hardly have passed over in less than twenty-two seconds,—should have afforded an ample space within which to stop the train. When the derailment took place, however, it was still moving at a considerable rate of speed. Both locomotives, the baggage car and six following passenger cars left the rails. The locomotives, after going a short distance, swung off to the left

and toppled over, presenting an insuperable barrier to the direct movement of the cars following.

Those cars were of the most approved form of American construction, but here, as at Shipton, the violent application of the train-brakes and reversal of the locomotives had greatly checked the speed of the forward part of the train, while the whole rear of it, comparatively free from brake pressure, was crowding heavily forward. Including its living freight, the entire weight of the train could not have been less than 500 tons. There was no slack between its parts; no opportunity to give. It was a simple question of the resisting power of car construction. Had the train consisted of ten cars instead of twenty-two a recent experience of a not dissimilar accident on this very road affords sufficient evidence of how different the result would have been. On the occasion referred to,—October 13, 1876,—a train consisting of two locomotives and fourteen cars, while rounding a curve before the Randolph station at a speed of thirty miles an hour came in sudden collision with the locomotive of a freight train which was occupying the track, and while doing so, in that case also as at Wollaston, had wholly neglected to protect it. So short was the notice of danger that the speed of the passenger train could not at the moment of collision have been less than twenty miles an hour. The freight train was at the moment fortunately backing, but none the less it was an impassable obstacle. The

three locomotives were entirely thrown from the track and more or less broken up, and three cars of the passenger train followed them, but the rest of it remained in line and on the rails, and was so entirely uninjured that it was not found necessary to withdraw one of the cars from service for even a single trip. Not a passenger was hurt. This train consisted of fourteen cars: but at Wollaston, the fourteen forward cars were, after the head of the train was derailed, driven onward not only by their own momentum but also by the almost unchecked momentum of eight other cars behind them. The rear of the train did not leave the rails and was freely moving along them. By itself it must have weighed over 200 tons. The result was inevitable. Something had to yield; and the six forward cars were accordingly either thrown wholly to the one side or the other, or crushed between the two locomotives and the rear of the train. Two of them in fact were reduced into a mere mass of fragments. The disaster resulted in the death of 19 persons, while a much greater number were injured, more than 50 seriously. In this as in most other railroad disasters the surprising thing was that the list of casualties was not larger. Looking at the position of the two cars crushed into fragments it seemed almost impossible that any person in them could have escaped alive. Indeed that they did so was largely due to the fact that the season for car-warming had not yet arrived, while, in some way impossible to

explain, all four of the men in charge of the locomotives, though flung violently through the air into the trees and ditch at the side of the road were neither stunned nor seriously injured. They were consequently able, as soon as they could gather themselves up, to take the measures necessary to extinguish the fires in their locomotives which otherwise would speedly have spread to the *débris* of the train. Had they not done so nothing could have saved the large number of passengers confined in the shattered cars.

CHAPTER IV.

ACCIDENTS AND CONSERVATISM.

THE four accidents which have been referred to, including that of April 17, 1836, upon the Manchester & Liverpool road, belong to one class. Though they covered a period of forty-two years they were all due to the same cause, the sudden derailment of a portion of the train, and its subsequent destruction because of the insufficient control of those in charge of it over its momentum. In the three earlier cases the appliances in use were much the same, for between 1836 and 1874 hardly any improvement as respects brakes had either forced its own way, or been forced by the government, into general acceptance in Great Britain. The Wollaston disaster, on the other hand, revealed a weak point in an improved appliance; the old danger seemed, indeed, to take a sort of pleasure in baffling human ingenuity. The Shipton accident, however, while one of the most fatal which ever occurred was also one of the most

fruitful in results. This, and the accident of April 17, 1836, upon the Manchester & Liverpool road were almost precisely similar, though no less than thirty-eight years intervened between them. In the case of the first, however, no one was killed and consequently it was wholly barren of results; for experience has shown that to bring about any considerable reform, railroad disasters have, as it were, to be emphasized by loss of life. This, however, implies nothing more than the assertion that those responsible for the management of railroads do not differ from other men,—that they are apt, after some hair-breadth escape, to bless their fortunate stars for the present good rather than to take anxious heed for future dangers.

At the time the Shipton accident occurred the success of the modern train-brake, which places the speed of each of the component parts of the train under the direct and instantaneous control of him who is in charge of the locomotive, had for years been conceded even by the least progressive of American railroad managers. The want of such a brake and the absence of proper means of communication between the parts of the train had directly and obviously caused the murderous destructiveness of the accident. Yet in the investigation which ensued it appeared that the authorities of the Great Western Railway, being eminently "practical men," still entertained as respected the train-brake "very grave doubts of the wisdom of adopting [it] at

all;" while at the same time, as respected a means of communication between the parts of the train, it appeared that the associated general managers of the leading railways "did not think that any [such] means of communication was at all required, or likely to be useful or successful."

Though quite incomprehensible, there is at the same time something superb in such an exhibition of stolid conservatism. It is British. It is, however, open to but one description of argument, the *ultima ratio* of railroad logic. So long as luck averted the loss of life in railroad disasters, no occasion would ever have been seen for disturbing time-honored precautions or antiquated appliances. While, however, a disaster like that of December 24, 1874, might not convince, it did compel: in spite of professed "grave doubts," incredulity and conservatism vanished, silenced, at least, in presence of so frightful a row of corpses as on that morning made ghastly the banks of the Cherwell. The general, though painfully slow and reluctant, introduction of train-brakes upon the railways of Great Britain may be said to have dated from that event.

In the matter of communication between those in the train and those in charge of it, the Shipton corpses chanced not to be witnesses to the precise point. Accordingly their evidence was, so to speak, ruled out of the case, and neither the utility nor the success of any appliance for this purpose was held to be yet proven. What further proof would be deemed

conclusive did not appear, but the history of the discussion before and since is not without value. There is, indeed, something almost ludicrously characteristic in the manner with which those interested in the railway management of Great Britain strain at their gnats while they swallow their camels. They have grappled with the great question of city travel with a superb financial and engineering sagacity, which has left all other communities hopelessly distanced; but, while carrying their passengers under and over the ebb and flow of the Thames and among the chimney pots of densest London to leave them on the very steps of the Royal Exchange, they have never been able to devise any satisfactory means for putting the traveller, in case of a disaster to the carriage in which he happens to be, in communication with the engine-driver of his train. An English substitute for the American bell-cord has for more than thirty years set the ingenuity of Great Britain at defiance.

As long ago as the year 1857, in consequence of two accidents to trains by fires, a circular on this subject was issued to the railway companies by the Board of Trade, in which it was stated that "from the beginning of the year 1854, down to the present time (December, 1857) there have been twenty-six cases in which either the accidents themselves or some of the ulterior consequences of the accidents would probably have been avoided had such a means

of communication existed." * As none of these accidents had resulted in any considerable number of funerals the railway managers wholly failed to see the propriety of this circular, or the necessity of taking any steps in consequence of it. As, however, accidents from this cause were still reported, and with increasing frequency, the authorities in July, 1864, again bestirred themselves and issued another circular in which it was stated that "several instances have occurred of carriages having taken fire, or having been thrown off the rails, the passengers in which had no means of making their perilous situation known to the servants of the company in charge of the train. Recent occurrences also of a criminal nature in passenger railway trains have excited among the public a very general feeling of alarm." The last reference was more particularly to the memorable Briggs murder, which had taken place only a few days before on July 9th, and was then absorbing the public attention to the almost entire exclusion of everything else.

* The bell-cord in America, notwithstanding the theoretical objections which have been urged to its adoption in other countries, has proved such a simple and perfect protection against dangers from inability to communicate between portions of trains that accidents from this cause do not enter into the consideration of American railroad managers. Yet they do, now and again, occur. For instance, on February 28, 1874, a passenger coach in a west-bound accommodation train of the Great Western railroad of Canada took fire from the falling of a lamp in the closet at its forward end. The bell-cord was for some reason not connected with the locomotive, and the train ran two miles before it could be stopped. The coach in question was entirely destroyed and eight passengers were either burned or suffocated, while no less than thirteen others sustained injuries in jumping from the train.

As no better illustration than this can be found of the extreme slowness with which the necessity for new railroad appliances is recognized in cases where profit is not involved, and of the value of wholesale slaughters, like those at Shipton and Angola, as a species of motive force in the direction of progress, a digression on the subject of English accidents due to the absence of bell-cords may be not without value. In the opinion of the railway managers the cases referred to by the Board of Trade officials failed to show the existence of any necessity for providing means of communication between portions of the train. A detailed statement of a few of the cases thus referred to will not only be found interesting in itself, but it will give some idea of the description of evidence which is considered insufficient. The circumstances of the Briggs murder, deeply interesting as they were, are too long for incidental statement; this, however, is not the case with some of the other occurrences. For instance, the Board of Trade circular was issued on July 30th; on July 7th, a year earlier, the following took place on the London & North Western road.

Two gentlemen took their seats at Liverpool in one of the compartments of the express train to London. In it they found already seated an elderly lady and a large, powerfully built man, apparently Irish, respectably dressed, but with a lowering, suspicious visage. Though one of the two gentlemen noticed this peculiarity as he entered the carriage,

he gave no thought to it, but, going on with their conversation, he and his friend took their seats, and in a few moments the train started. Scarcely was it out of the station when the stranger changed his seat, placing himself on the other side of the carriage, close to the window, and at the same time, in a menacing way, incoherently muttering something to himself. The other passengers looked at him, but felt no particular alarm, and for a time he remained quietly in his seat. He then suddenly sprang up, and, with a large clasp-knife in his hand, rushed at one of the gentlemen, a Mr. Warland by name, and struck him on the forehead, the knife sliding along the bone and inflicting a frightful flesh wound. As he was in the act of repeating the blow, Warland's companion thrust him back upon the seat. This seemed to infuriate him, and starting to his feet he again tried to attack the wounded man. A frightful struggle ensued. It was a struggle for life, in a narrow compartment feebly lighted, for it was late at night, on a train running at full speed and with no stopping place for eighty miles. The passenger who had not been hurt clutched the maniac by the throat with one hand and grasped his knife with the other, but only to feel the blade drawn through his fingers, cutting them to the bone. The unfortunate elderly woman, the remaining occupant of the compartment, after screaming violently in her terror for a few moments, fainted away and fell upon the floor. The struggle nevertheless went on among the three men,

until at last, though blinded with blood and weak from its loss, the wounded Mr. Warland got behind his assailant and threw him down, in which position the two succeeded in holding him, he striking and stabbing at both of them with his knife, shouting loudly all the time, and desperately endeavoring to rise and throw them off. They finally, however, got his knife away from him, and then kept him down until the train at last drew up at Camdentown station. When the ticket collector opened the compartment door at that place he found the four passengers on the floor, the woman senseless and two of the men holding the third, while the faces and clothing of all of them, together with seats, floor, windows and sides of the carriage were covered with blood or smeared with finger marks.

The assailant in this case, as it subsequently appeared upon his commitment for an assault, was a schoolmaster who had come over from Ireland to a competitive examination. He was insane, of course, but before the magistrate he made a statement which had in it something quite touching; he said that he saw the two gentlemen talking together, and, as he thought, making motions towards him; he believed them to be thieves who intended to rob him, and so he thought that he could not do better than defend himself, "if only for his dear little ones at home."

This took place before the Board of Trade circular

was issued, but, as if to give emphasis to it, a few days only after its issue, in August, 1864, there was a not dissimilar occurrence in a third class carriage between London and Peterborough. The running distance was in this case eighty miles without a stop, and occupied generally an hour and fifty minutes,—the rate being forty-three miles an hour. In the compartment in question were five passengers, one of whom, a tall powerful fellow, was dressed like a sailor. The train was hardly out of London when this man, after searching his pockets for a moment, cried out that he had been robbed of his purse containing £17, and began violently to shout and gesticulate. He then tried to clamber through the window, getting his body and one leg out, and when his fellow passengers, catching hold of his other leg, succeeded in hauling him back, he turned savagely upon them and a desperate struggle ensued. At last he was gotten down by main force and bound to a seat. Meanwhile, notwithstanding the speed at which they were running, the noise of the struggle was heard in the adjoining compartments, and almost frantic efforts were made to stop the train. Word was passed from carriage to carriage for a short distance, but it proved impossible to communicate with the guard, or to do anything but thoroughly alarm the passengers. These merely knew that something was the matter,—what, they could only imagine,—and so the run to Peterborough was completed amid shouts of "stop the train," interspersed with frantic

female shrieks. The man was suffering from *delirium tremens.*

About a year later, in December, 1865, a similar case occurred which, however, had in it strong elements of the ludicrous. A clergyman, laboring under great indignation and excitement, and without the slightest sense of the ridiculous, recounted his experience in a communication to the *Times.* He had found himself alone in a compartment of an express train in which were also a young lady and a man, both total strangers to him. Shortly after the train started the man began to give unmistakable indications of something wrong. He made no attempt at any violence on either of his fellow passengers, but he was noisy, and presently he proceeded to disrobe himself and otherwise to indulge in antics which were even more indecent than they were extraordinary. The poor clergyman,—a respected incumbent of the established church returning to the bosom of his family,—was in a most distressing situation. At first he attempted remonstrance. This, however, proved worse than unavailing, and there was nothing for it but to have recourse to his umbrella, behind the sheltering cover of which he protected the modesty of the young lady, while over its edges he himself from time to time effected observations through an apparently interminable journey of forty and more miles.

These and numerous other cases of fires, murders, assaults and indecencies had occurred and filled the

columns of the newspapers, without producing the slightest effect on the managers of the railway companies. No attention was paid by them to the Board of Trade circulars. At last Parliament took the matter up and in 1868 an act was passed, making compulsory some "efficient means of communication between the passenger and the servants of the company in charge" of railroad trains. Yet when six years later in 1874 the Shipton accident occurred, and was thought to be in some degree attributable to the absence of the very means of communication thus made compulsory, it appeared, as has been seen, that the associated general managers did not yet consider any such means of communication either required or likely to be useful.

Meanwhile, as if in ironical comment on such measured utterances, occurrences like the following, which took place as recently as the early part of 1878, from time to time still meet the eye in the columns of the English press:—

"A burglar was being taken in a third-class carriage from London to Sheffield. When about twelve miles from Sheffield he asked that the windows might be opened. This was no sooner done than he took a dive out through the aperture. One of the warders succeeded in catching him by a foot, and for two miles he hung head downward suspended by one foot and making terrific struggles to free himself. In vain he wriggled, for although his captors were unable to catch the other foot, both held him as in a vise. But he wore spring-sided boots, and the one on which his fate seemingly depended came off. The burglar fell heavily on the foot-board of

the carriage and rolled off on the railway. Three miles further on the train stopped, and the warders went back to the scene of the escape. Here they found him in the snow bleeding from a wound on the head. During the time he was struggling with the warders the warder who had one hand free and the passengers of the other compartments who were witnessing the scene from the windows of the train were indefatigable in their efforts to attract the attention of the guards by means of the communication cord, but with no result. For two miles the unfortunate man hung head downward, and for three miles further the train ran until it stopped at an ordinary resting place."

A single further example will more than sufficiently illustrate this instance of British railroad conservatism, and indicate the tremendous nature of the pressure which has been required to even partially force the American bell-cord into use in that country. One day, in the latter part of 1876, a Mr. A. J. Ellis of Liverpool had occasion to go to Chester. On his way there he had an experience with a lunatic, which he subsequently recounted before a magistrate as follows:—

"On Friday last I took the 10.35 A.M., train from Lime Street in a third-class carriage, my destination being Chester. At Edge Hill Station the prisoner and another man, whom I afterward understood to be the prisoner's father, got into the same compartment, no one else being in the same compartment. The other person was much under the influence of drink when he entered, and was very noisy during the journey. The prisoner had the appearance of having been drinking, but was quiet. I sat with my back to the engine, on the getting-out side of the carriage; prisoner was sitting on the opposite side, with his right arm to the window, and the other person was

sitting on the same side as prisoner, about the middle of the seat. I was engaged reading, and did not exchange words with the prisoner.

"After we had passed over Runcorn bridge and through the station, I perceived the prisoner make a start, and looking toward him saw a white-hafted knife in his hand, about five inches long, with the blade open. He held it in his right hand in a menacing manner. Drawing his left hand along the edge of the blade, he said, "This will have to go into some ——." At that moment he looked at me across the carriage; he was on his feet in an instant, and looking across to me, he said, "You ——, this will have to go into you," and made a bound toward me. The other jumped up and tried to prevent him. The prisoner threw him away; he made a plunge at my throat. I caught his wrist just as he advanced, and struggled with him, still holding fast to his wrist with both hands. We fell over and under one another two or three times, and eventually he overpowered me. I had fallen on my side on the seat, but still retained my hold upon his wrist. While lying in that position he held the knife down to within an inch of my throat. I called to the other man to hold the prisoner's hand back which contained the knife, and by that means he saved my life. I was growing powerless, and as the other man restrained the prisoner from using the knife, I jerked myself from his grasp, and knocked the knife out of the prisoner's hand with my left hand.

"The prisoner eluded the grip of his father, and falling on his knees began to seek for his knife. Failing to find the knife, he was instantly on his feet, and made a spring upon me. If I recollect aright, he threw his arms around my neck, and in this manner we struggled together up and down the carriage for some minutes, during which time he got my left thumb (with a glove on at the time) in his mouth, and bit it. Still retaining my thumb in his mouth, the other man struck him under the chin, when he released it; and fell on his knees seeking the knife, which

he did not find. He was immediately on his feet, and again made a spring upon me. We had then a very long and desperate struggle, when he overpowered me and pinned me in a corner of the compartment. At last he got my right thumb into his mouth, holding my hand to steady it with both his hands while he bit it. With a great effort he then bit my thumb off, clean to the bone. I had no glove on that hand. I called to the other man to help me, but he seemed stupefied. He called two or three times to the prisoner, 'Leave the poor man alone. The poor man has done thee no harm.' Though sitting within nine inches of my knees he rendered me no help.

"When the prisoner bit my thumb off, he held it in his mouth; he pushed his head through the glass, spat the thumb into his hand and flung it out through the window. I then stood up and put my left hand in my pocket, took out my purse and cried out: 'If it is money you want take all I have.' He made a grab at the purse and flung it through the window, on the same side as the thumb was thrown out. From this act I inferred that I was struggling with a maniac. I retreated to the other end of the compartment, holding the other man between me and the prisoner, but he passed the other man by jumping over the seat and again got hold of me. Then he forced his head through the other window, breaking the glass, and, loosing me for a moment, with his fists smashed the remaining glass in the window. Addressing me he said: 'You ——, you will have to go over;' at the same time he flung both his arms around my waist. I put my leg behind his and threw him on his back. I called upon the other man to help me and he did so.

"We held him down for some time, but he overpowered us and flung us back some distance. He then laid hold of my travelling rug and threw it through the window. Laying his hand on the bottom of the window he cried out, 'Here goes,' and made a leap through the window. I and the other man instantly laid hold of his legs as he

was falling over. I got my four fingers into his right shoe, and, his father assisting me, we held him through the window, hanging head downward for about half a mile. I then fainted, and as I was losing my hold on his heels I have some faint recollection that the prisoner's father lost his hold at the same time, and I can't say what happened afterward. As I was coming to myself the train was stopping, and I heard the other man say, 'Oh, my son, my son.' When the train stopped I walked from the carriage to the station, and Dr. Robinson, who was sent for, came in about an hour and amputated my thumb further back."

While thus referring, however, to this instance of British railroad conservatism, which with a stolid indifference seems to ignore the teachings of every day life and to meet constantly recurring experience with a calm defiance, it will not do for the American railroad manager to pride himself too much on his own greater ingenuity and more amenable disposition. The Angola disaster has been referred to, as well as that at Shipton. If the absence of the bell-cord had indeed any part in the fatality of the latter, the presence in cars crowded with passengers of iron pots full of living fire lent horrors before almost unheard of to the former. The methods of accomplishing needed results which are usual to any people are never easily changed, whether in Europe or in America; but certainly the disasters which have first and last ensued from the failure to devise any safe means of heating passenger coaches in this country are out of all proportion to those which can be attributed in England to the absence of means of

communication between the passengers on trains and those in charge of them. There is an American conservatism as well as an English; and when it comes to a question of running risks it would be strange indeed if the greater margin of security were found west of the Atlantic. The security afforded by the bell-cord assuredly has not as yet in this country off-set the danger incident to red-hot stoves.

CHAPTER V.

TELESCOPING AND THE MILLER PLATFORM.

THE period of exemption from wholesale railroad slaughters referred to in a previous chapter and which fortunately marked the early days of the system, seems to have lasted some eleven years. The record of great catastrophes opened on the Great Western railway of England, and it opened also, curiously enough, upon the 24th of December, a day which seems to have been peculiarly unfortunate in the annals of that corporation, seeing that it was likewise the date of the Shipton-on-Cherwell disaster. Upon that day, in 1841, a train, while moving through a thick fog at a high rate of speed, came suddenly in contact with a mass of earth that had slid down upon the track from the slope of the cutting. Instantly the whole rear of the train was piled up on the top of the first carriage, which happened to be crowded with passengers, eight of whom were killed on the spot while

seventeen others were more or less injured. The coroner's jury returned a verdict of accidental death, and at the same time, as if to give the corporation a forcible hint to look closer to the condition of its roadway, a "deodand" of one hundred pounds was levied on the locomotive and tender. This practice, by the way, of levying a deodand in cases of railroad accidents resulting in loss of life, affords a curious illustration of how seldom those accidents must have occurred. The mere mention of it now as ever having existed sounds almost as strange and unreal as would an assertion that the corporations had in their earlier days been wont to settle their differences by wager of battle. Like the wager of battle, the deodand was a feature of the English common law derived from the feudal period. It was nothing more nor less than a species of fine, everything through the instrumentality of which accidental death occurred being forfeited to the crown; or, in lieu of the thing itself, its supposed money value as assessed by a coroner's jury.* Accordingly, down to somewhere about the year 1847, when the practice was finally abolished by act of Parliament, we find

* "*Deodand.* By this is meant whatever personal chattel is the immediate occasion of the death of any reasonable creature: which is forfeited to the king, to be applied to pious uses, and distributed in alms by his high almoner; though formerly destined to a more superstitious purpose. * * * Wherever the thing is in motion, not only that part which immediately gives the wounds (as the wheel which runs over his body,) but all things which move with it and help to make the wound more dangerous, (as the cart and loading, which increase the pressure of the wheel) are forfeited."—*Blackstone, Book I, Chap.* 8, *XVI.*

in all cases of English railroad accidents resulting in death, mention of the deodand assessed by coroner's juries on the locomotives. These appear to have been arbitrarily fixed, and graduated in amount as the circumstances of the particular accident seemed to excite in greater or less degree the sympathies or the indignation of the jury. In November, 1838, for instance, a locomotive exploded on the Manchester & Liverpool road, killing its engineer and fireman: and for this escapade a deodand of twenty pounds was assessed upon it by the coroner's jury; while upon another occasion, in 1839, where the locomotive struck and killed a man and horse at a street crossing, the deodand was fixed at no less a sum than fourteen hundred pounds, the full value of the engine. Yet in this last case there did not appear to be any circumstances rendering the corporation liable in civil damages. The deodand seems to have been looked upon as a species of rude penalty imposed on the use of dangerous appliances,—a sharp reminder to the corporations to look closely after their locomotives and employés. As, however, accidents increased in frequency it became painfully apparent that "crowner's 'quest law" was not in any appreciable degree better calculated to command the public respect in the days of Victoria than in those of Elizabeth, and the ancient usage was accordingly at last abolished. Certainly the position of railroad corporations would now be even more hazardous than it is, if, after every catastrophe

resulting in death, the coroner's jury of the vicinage enjoyed the power of arbitrarily imposing on them such additional penalty not exceeding the value of a locomotive, in addition to all other liabilities, as might seem to it proper under the circumstances of the case.

Recurring, however, to the accident of December 24, 1861, the numerous casualities in that case were due to the crushing of the rolling stock which was not strong enough to resist the shock of the sudden stop. Under these circumstances the light, short English carriages rode over each other and were broken to pieces; under similar circumstances the longer and heavier cars then in use in America would have "telescoped;" that is, the platformsb etween the cars would have been broken off and the forward end of each car riding slightly up on its broken coupling would have shot in over the floor of the car before it, sweeping away the studding and other light wood-work and crushing stoves, seats and passengers into one inextricable mass, until, if the momentum was sufficiently great, the several vehicles in the train would be enclosed in each other somewhat like the slides of a partially shut telescope.

Crushing in other countries and telescoping in America were formerly the greatest, if not the worst, dangers to which travel by rail was liable. As respects crushing there is little to be said. It is a mere question of proportions,—resisting strength

opposed to momentum. So long as trains go at great speed it is inevitable that they will occasionally be brought to a dead-stand by running upon unexpected obstacles. The simple wonder is that they do this so infrequently. When, however, now and again, they are thus brought to a dead-stand the safety of the passenger depends and can depend on nothing but the strength of the car in which he is sitting as measured by the force of the shock to which it is subjected. This matter has already been referred to in connection with the Shipton and Wollaston accidents,* the last of which was a significant reminder to all railroad managers that no matter how strongly or with how careful a regard to scientific principles cars may be constructed, just so long as they are made by human hands it is easy to load on weight sufficient, when combined with only a moderate momentum, to crush them into splinters.

Telescoping, however, was an incident of crushing, and a peculiarly American incident, which is not without a certain historical interest; for the particular feature in car construction which led directly to it and all its attendant train of grisly horrors furnishes a singular and instructive illustration of the gross violations of mechanical principles into which practical, as opposed to educated, mechanics are apt constantly to fall,—and in which, when once they have fallen, they steadily persist. The

*Ante pp. 18–19.

original idea of the railroad train was a succession of stage coaches chained together and hauled by a locomotive. The famous pioneer train of August 9, 1831, over the Mohawk Valley road was literally made up in this way, the bodies of stage coaches having been placed on trucks, which "were coupled together with chains or chain-links, leaving from two to three feet slack, and when the locomotive started it took up the slack by jerks, with sufficient force to jerk the passengers, who sat on seats across the tops of the coaches, out from under their hats, and in stopping they came together with such force as to send them flying from their seats." On this trip, it will be remembered, the train presently came to a stop, when the passengers upon it, with true American adaptability, set their wits at once to the work of devising some means of remedying the unpleasant jerks.* "A plan was soon hit upon and put in execution. The three links in the couplings of the cars were stretched to their utmost tension, a rail, from a fence in the neighborhood, was placed between each pair of cars and made fast by means of the packing yarn from the cylinders." Here was the incipient idea of couplers and buffers improvised by practical men, and for a third of a century it remained almost unimproved upon, except by the introduction of a spring upon which coupler and buffer played. The only other considerable change made in the

* Railroads: their Origin and Problems, p. 49.

earlier days of car construction was by no means an improvement, inasmuch as it introduced the new and wholly unnecessary danger of telescoping.

The original passenger cars, however frail and light they may have been, were at least, when shackled together in a train, continuous in their bearings on each other,—that is, their sills and floor timbers were all on a level and in line, so that, if the cars were suddenly pressed together, they met in such a way as to resist the pressure to the extent of their resisting power, and the floor of one did not quietly slide under or over that of another. The bodies of these cars were about thirty-two inches from the rails. This was presently found to be too low. In raising the bodies of the cars, however, the mechanics of those days encountered a practical difficulty. The couplings of the cars built on the new model were higher than those of the old. They at once met, and, as they thought, no less ingeniously then successfully overcame this difficulty, by placing the couplings and draw-heads of their new cars below the line of the sills. This necessitated putting the platform which sustained the coupling also beneath the sills, and in doing that they disregarded, without the most remote consciousness of the fact, a fundamental law of mechanics. With a possible pressure, both sudden and heavy to be resisted, the line of resistance was no longer the line of greatest strength. During thirty years this stupid blunder remained uncor-

rected. It was as if the builders during that period had from force of habit insisted upon always using as supports pillars which were curved or bent instead of upright. At the close of those thirty years also the railroad mechanics had become so thoroughly educated into their false methods that it took yet other years and a series of frightful disasters, the significance of which they seemed utterly unable to take in, before they could be induced to abandon those methods.

The two great dangers of telescoping and oscillation were directly due to this system of car construction and of train coupling,—and telescoping and oscillation were probably the cause of one-half at least of the loss of life and the injuries to persons incident to the first thirty years of American railroad experience. The badly built and loosely connected coaches of every train going at any considerable rate of speed used then to swing and roll about and hammer against each other after a fashion which made the infrequent occurrence of serious disaster the only fair subject for surprise. In case of a sudden stoppage or partial derailment, the train stopped or went on, not as a whole, but as a succession of parts, while the low platforms and slack couplings fearfully increased the danger;—for, if the train held together, the cars in stopping were likely to break off the platforms, making of what remained of them a sort of inclined plane over which the car-bodies rode into each other at differ-

ent levels; or, if the couplings, as was more probable, held and the train did not part, the swaying and swinging of the loosely connected cars was almost sure to throw them from the track and break them in pieces. The invention through which this difficulty was at last overcome, simple and obvious as it was, is fairly entitled, so far as America at least is concerned, to be classed among the four or five really noticeable advances which have of late years been made in railroad appliances. It contributed unmistakably and essentially to the safety of every traveller. Known as the Miller platform and buffer, from the name of the inventor, it was, like all good work of the sort, a simple and intelligent recurrence to correct mechanical principles. Miller went to work to construct cars in such a way as to cause them to come in contact with each other in the line of their greatest resisting power, while in coupling them together in trains he introduced both tension and compression;—that is he, in plain language, brought the ends of the heavy longitudinal floor timbers of the separate cars exactly on a line and directly bearing on each other, and then forced them against each other until the heavy spring buffers which played on those floor timbers were compressed, when the couplers sprung together and the train then stood practically one solid body from end to end. It could no more swing or crush than a single car could swing or crush. It then only remained to

increase the weight and to perfect the construction of the vehicles to insure all the safety in this respect of which travel by rail admitted.

Simple as these improvements were, and apparently obvious as the mechanical principles on which they were based now seem, the opposition for years offered to them by practical master-mechanics and railroad men would have been ludicrous had it not been exasperating. There was hardly a railroad in the country whose officers did not insist that their method of construction was exceptional, it was true, but far better than Miller's. It was maintained that the slack couplings were necessary in order to enable the locomotives to start the trains, —that a train made up without the slack, on Miller's plan, could not be set in motion, and that if it was set in motion it must twist apart at every sharp curve etc. The ingenuity displayed in thus inventing theoretical objections to the appliance far exceeded that required for inventing it, and indeed no one who has not had official experience of it can at all realize the objecting capacity of the typical practical mechanic whose conceit as a rule is measured by his ignorance, while his stupidity is unequalled save by his obstinacy. Even when Miller's invention for one reason or another was not adopted, the principles upon which that invention was founded,—the principles of tension, cohesion and direct resistance,—at last forced their way into general acceptance. The long-urged ob-

jection that the thing was practically impossible was slowly abandoned in face of the awkward but undeniable fact that it was done every day, and many times a day. Consequently, as the result of much patient arguing, duly emphasized by the regular recurrence of disaster, it is not too much to assert that for weight, resisting power, perfection of construction and equipment and the protection they afford to travellers, the standard American passenger coach is now far in advance of any other. As to comfort, convenience, taste in ornamentation, etc., these are so much matters of habit and education that it is unnecessary to discuss them. They do not affect the question of safety.

A very striking illustration of the vast increase of safety secured through this improved car construction was furnished in an accident, which happened in Massachusetts upon July 15, 1872. As an express train on the Boston & Providence road was that day running to Boston about noon and at a rate of speed of some forty miles an hour, it came in contact with a horse and wagon at a grade crossing in the town of Foxborough. The train was made up of thoroughly well-built cars, equipped with both the Miller platform and the Westinghouse train-brake. There was no time in which to check the speed, and it thus became a simple question of strength of construction, to be tested in an unavoidable collision. The engine struck the wagon, and instantly destroyed it. The horse had already cleared the rails when the

wagon was struck, but, a portion of his harness getting caught on the locomotive, he was thrown down and dragged a short distance until his body came in contact with the platform of a station close to the spot of collision. The body was then forced under the cars, having been almost instantaneously rolled and pounded up into a hard, unyielding mass. The results which ensued were certainly very singular. Next to the locomotive was an ordinary baggage and mail car, and it was under this car, and between its forward and its hind truck, that the body of the horse was forced; coming then directly in contact with the truck of the rear wheels, it tore it from its fastenings and thus let the rear end of the car drop upon the track. In falling, this end snapped the coupling by its weight, and so disconnected the train, the locomotive going off towards Boston dragging this single car, with one end of it bumping along the track. Meanwhile the succeeding car of the train had swept over the body of the horse and the disconnected truck, which were thus brought in contact with its own wheels, which in their turn were also torn off; and so great was the momentum that in this way all of the four passenger cars which composed that part of the train were successively driven clean off their rolling gear, and not only did they then slide off the track, but they crossed a railroad siding which happened to be at that point, went down an embankment three or four feet in height, demolished a fence, passed into an adjoining

field, and then at last, after glancing from the stump of a large oak-tree, they finally came to a stand-still some two hundred feet from the point at which they had left the track. There was not in this case even an approach to telescoping; on the contrary, each car rested perfectly firmly in its place as regarded all the others, not a person was injured, and when the wheelless train at last became stationary the astonished passengers got up and hurried through the doors, the very glass in which as well as that in the windows was unbroken. Here was an indisputable victory of skill and science over accident, showing most vividly to what an infinitesimal extreme the dangers incident to telescoping may be reduced.

The vast progress in this direction made within twenty years can, however, best perhaps be illustrated by the results of two accidents almost precisely similar in character, which occurred, the one on the Great Western railroad of Canada, in October, 1854, the other on the Boston & Albany, in Massachusetts, in October, 1874. In the first case a regular train made up of a locomotive and seven cars, while approaching Detroit at a speed of some twenty miles an hour, ran into a gravel train of fifteen cars which was backing towards it at a speed of some ten miles an hour. The locomotive of the passenger train was thrown completely off the track and down the embankment, dragging after it a baggage car. At the head of the passenger portion of the train were two second-class cars filled with emigrants; both of these

were telescoped and demolished, and all their unfortunate occupants either killed or injured. The front of the succeeding first-class car was then crushed in, and a number of those in it were hurt. In all, no less than forty-seven persons lost their lives, while sixty others were maimed or severely bruised. So much for a collision in October, 1854. In October, 1874, on the Boston & Albany road, the regular New York express train, consisting of a locomotive and seven cars, while going during the night at a speed of forty miles an hour, was suddenly, near the Brimfield station, thrown by a misplaced switch into a siding upon which a number of platform freight cars were standing. The train was thoroughly equipped, having both Miller platform and Westinghouse brake. The six seconds which intervened, in the darkness, between notice of displacement and the collision did not enable the engineer to check perceptibly the speed of his train, and when the blow came it was a simple question of strength to resist. The shock must have been tremendous, for the locomotive and tender were flung off the track to the right and the baggage car to the left, the last being thrown across the interval between the siding and the main track and resting obliquely over the latter. The forward end of the first passenger coach was thrown beyond the baggage car up over the tender, and its rear end, as well as the forward end of the succeeding coach, was injured. As in the Foxborough case, several of the trucks were jerked out from under.

the cars to which they belonged, but not a person on the train was more than slightly bruised, the cars were not disconnected, nor was there even a suggestion of telescoping.

CHAPTER VI.

THE VERSAILLES ACCIDENT.

GOING back once more to the early days, a third of a century since, before yet the periodical recurrence of slaughter had caused either train-brake or Miller platform to be imagined as possibilities, before, indeed, there was yet any record of what we would now consider a regular railroad field-day, with its long train of accompanying horrors, including in the grisly array death by crushing, scalding, drowning, burning, and impalement,—going back to the year 1840, or thereabouts, we find that the railroad companies experienced a notable illustration of the truth of the ancient adage that it never rains but it pours; for it was then that the long immunity was rudely broken in upon. After that time disasters on the rail seemed to tread upon one another's heels in quick and frightful succession. Within a few months of the English catastrophe of December 24, 1841, there happened in France one of the most

famous and most horrible railroad slaughters ever recorded. It took place on the 8th of May, 1842. It was the birthday of the king, Louis Philippe, and, in accordance with the usual practice, the occasion had been celebrated at Versailles by a great display of the fountains. At half past five o'clock these had stopped playing, and a general rush ensued for the trains then about to leave for Paris. That which went by the road along the left bank of the Seine was densely crowded, and so long that two locomotives were required to draw it. As it was moving at a high rate of speed between Bellevue and Meudon, the axle of the foremost of these two locomotives broke, letting the body of the engine drop to the ground. It instantly stopped, and the second locomotive was then driven by its impetus on top of the first, crushing its engineer and fireman, while the contents of both the fire-boxes were scattered over the roadway and among the *débris*. Three carriages crowded with passengers were then piled on top of this burning mass and there crushed together into each other. The doors of these carriages were locked, as was then and indeed is still the custom in Europe, and it so chanced that they had all been newly painted They blazed up like pine kindlings. Some of the carriages were so shattered that a portion of those in them were enabled to extricate themselves, but the very much larger number were held fast; and of these such as were not so fortunate as to be crushed to death in the first shock perished hope-

lessly in the flames before the eyes of a throng of lookers-on impotent to aid. Fifty-two or fifty-three persons were supposed to have lost their lives in this disaster, and more than forty others were injured; the exact number of the killed, however, could never be ascertained, as the piling-up of the cars on top of the two locomotives had made of the destroyed portion of the train a veritable holocaust of the most hideous description. Not only did whole families perish together,—in one case no less than eleven members of the same family sharing a common fate,—but the remains of such as were destroyed could neither be identified nor separated. In one case a female foot was alone recognizable, while in others the bodies were calcined and and fused into an indistinguishable mass. The Academy of Sciences appointed a committee to inquire whether Admiral D'Urville, a distinguished French navigator, was among the victims. His body was thought to be found, but it was so terribly mutilated that it could be recognized only by a sculptor, who chanced some time before to have taken a phrenological cast of the skull. His wife and only son had perished with him.

It is not easy now to conceive the excitement and dismay which this catastrophe caused throughout France. The railroad was at once associated in the minds of an excitable people with novel forms of imminent death. France had at best been laggard enough in its adoption of the new invention,

and now it seemed for a time as if the Versailles disaster was to operate as a barrier in the way of all further railroad development. Persons availed themselves of the steam roads already constructed as rarely as possible, and then in fear and trembling, while steps were taken to substitute horse for steam power on other roads then in process of construction.

The disaster was, indeed, one well calculated to make a deep impression on the popular mind, for it lacked almost no attribute of the dramatic and terrible. There were circumstances connected with it, too, which gave it a sort of moral significance,—contrasting so suddenly the joyous return from the country *fête* in the pleasant afternoon of May, with what De Quincey has called the vision of sudden death. It contained a whole homily on the familiar text. As respects the number of those killed and injured, also, the Versailles accident has not often been surpassed; perhaps never in France. In this country it was surpassed on one occasion, among others, under circumstances very similar to it. This was the accident at Camphill station, about twelve miles from Philadelphia, on July 17, 1856, which befell an excursion train carrying some eleven hundred children, who had gone out on a Sunday-school picnic in charge of their teachers and friends.

It was the usual story. The road had but a single track, and the train, both long and heavy, had been delayed and was running behind its schedule time. The conductor thought, however, that the next sta-

tion could yet be reached in time to meet and there pass a regular train coming towards him. It may have been a miscalculation of seconds, it may have been a difference of watches, or perhaps the regular train was slightly before its time; but, however it happened, as the excursion train, while running at speed, was rounding a reverse curve, it came full upon the regular train, which had just left the station. In those days, as compared with the present, the cars were but egg-shells, and the shock was terrific. The locomotives struck each other, and, after rearing themselves up for an instant, it is said, like living animals, fell to the ground mere masses of rubbish. In any case the force of the shock was sufficient to hurl both engines from the track and lay them side by side at right angles to, and some distance from it. As only the excursion train happened to be running at speed, it alone had all the impetus necessary for telescoping; three of its cars accordingly closed in upon each other, and the children in them were crushed; as in the Versailles accident, two succeeding cars were driven upon this mass, and then fire was set to the whole from the ruins of the locomotives. It would be hard to imagine anything more thoroughly heart-rending, for the holocaust was of little children on a party of pleasure. Five cars in all were burned, and sixty-six persons perished; the injured numbered more than a hundred.*

*A collision very similar to that at Camphill occurred upon the

Of this disaster nothing could be said either in excuse or in extenuation; it was not only one of the worst description, but it was one of that description the occurrence of which is most frequent. An excursion train, while running against time on a single-track road, came in collision with a regular train. The record is full of similar disasters, too numerous to admit of specific reference. Primarily of course, the conductors of the special trains are as a rule in fault in such cases. He certainly was at Camphill, and felt himself to be so, for the next day he committed suicide by swallowing arsenic. But in reality in these and in all similar cases,—both those which have happened and those hereafter surely destined to happen,—the full responsibility

Erie railway at a point about 20 miles west of Port Jervis on the afternoon of July 15, 1864. The train in this case consisted of eighteen cars, in which were some 850 Confederate soldiers on their way under guard to the prisoner's camp at Elmira. A coal train consisting of 50 loaded cars from the hanch took the main line at Lackawaxen. The telegraph operator there informed its conductor that the track was clear, and, while rounding a sharp reversed curve, the two trains came together, the one going at about twelve and the other at some twenty miles an hour. Some 60 of the soldiers, besides a number of train hands were killed on the spot, and 120 more were seriously injured, some of them fatally.

This disaster occurred in the midst of some of the most important operations of the Rebellion and excited at the time hardly any notice. There was a suggestive military promptness in the subsequent proceedings. "T. J. Ridgeway, Esq., Associate Judge of Pike County, was soon on the spot, and, after consultation with Mr. Riddle [the superintendent of the Erie road] and the officer in command of the men, a jury was impanneled and an inquest held; after which a large trench was dug by the soldiers and the railway employés, 76 feet long, 8 feet wide and 6 feet deep, in which the bodies were at once interred in boxes, hastily constructed—one being allotted to four rebels, and one to each Union soldier." There were sixteen of the latter killed.

does not rest upon the unfortunate or careless subordinate;—nor should the weight of punishment be visited upon him. It belongs elsewhere. At this late day no board of directors, nor president, nor superintendent has any right to operate a single track road without the systematic use of the telegraph in connection with its train movements. That the telegraph can be used to block, as it is termed, double-track roads, by dividing them into sections upon no one of which two trains can be running at the same time, is matter of long and daily experience. There is nothing new or experimental about it. It is a system which has been forced on the more crowded lines of the world as an alternative to perennial killings. That in the year 1879 excursion trains should rush along single-track roads and hurl themselves against regular trains, just as was done twenty-three years ago at Camphill, would be deemed incredible were not exactly similar accidents still from time to time reported. One occurred near St. Louis, for instance, on July 4, 1879. The simple fact is that to now operate single-track roads without the constant aid of the telegraph, as a means of blocking them for every irregular train, indicates a degree of wanton carelessness, or an excess of incompetence, for which adequate provision should be made in the criminal law. Nothing but this appeal to the whipping-post, as it were, seems to produce the needed mental activity; for it is difficult to realize the

stupid conservatism of ordinary men when brought to the consideration of something to which they are not accustomed. On this very point of controlling the train movement of single-track roads by telegraph, for instance, within a very recent period the superintendent of a leading Massachusetts road gravely assured the railroad commissioners of that state, that he considered it a most dangerous reliance which had occasioned many disasters, and that he had no doubt it would be speedily abandoned as a practice in favor of the old time-table and running-rules system, from which no deviations would be allowed. This opinion was expressed, also, after the Revere disaster of 1871, it might have been supposed, had branded into the record of the state the impossibility of safely running any crowded railroad in a reliance upon the schedule.* Such men as this, however, are not accessible to argument or the teachings of experience, and the gentle stimulant of a criminal prosecution seems to be the only thing left.

* Chapter XIV, XVI.

CHAPTER VII.

TELEGRAPHIC COLLISIONS.

AND yet, even with the wires in active use, collisions will occasionally take place. They have sometimes, indeed, even been caused by the telegraph, so that railroad officials at two adjacent stations on the same road, having launched trains at each other beyond recall, have busied themselves while waiting for tidings of the inevitable collision in summoning medical assistance for those sure soon to be injured. In such cases, however, the mishap can almost invariably be traced to some defect in the system under which the telegraph is used ;—such as a neglect to exact return messages to insure accuracy, or the delegating to inexperienced subordinates the work which can be properly performed only by a principal. This was singularly illustrated in a terrible collision which took place at Thorpe, between Norwich and Great Yarmouth, on the Great Eastern Railway in England, on the 10th of September,

1874. The line had in this place but a single track, and the mail train to Norwich, under the rule, had to wait at a station called Brundell until the arrival there of the evening express from Yarmouth, or until it received permission by the telegraph to proceed. On the evening of the disaster the express train was somewhat behind its time, and the inspector wrote a dispatch directing the mail to come forward without waiting for it. This dispatch he left in the telegraph office unsigned, while he went to attend to other matters. Just then the express train came along, and he at once allowed it to proceed. Hardly was it under way when the unsigned dispatch occurred to him, and the unfortunate man dashed to the telegraph office only to learn that the operator had forwarded it. Under the rules of the company no return message was required. A second dispatch was instantly sent to Brundell to stop the mail; the reply came back that the mail was gone. A collision was inevitable.

The two trains were of very equal weight, the one consisting of fourteen and the other of thirteen carriages. They were both drawn by powerful locomotives, the drivers of which had reason for putting on an increased speed, believing, as each had cause to believe, that the other was waiting for him. The night was intensely dark and it was raining heavily, so that, even if the brakes were applied, the wheels would slide along the slippery track. Under these circumstances the two trains rushed upon each

other around a slight curve which sufficed to conceal their head-lights. The combined momentum must have amounted to little less than sixty miles an hour, and the shock was heard through all the neighboring village. The smoke-stack of the locomotive drawing the mail train was swept away as the other locomotive seemed to rush on top of it, while the carriages of both trains followed until a mound of locomotives and shattered cars was formed which the descending torrents alone hindered from becoming a funeral pyre. So sudden was the collision that the driver of one of the engines did not apparently have an opportunity to shut off the steam, and his locomotive, though forced from the track and disabled, yet remained some time in operation in the midst of the wreck. In both trains, very fortunately, there were a number of empty cars between the locomotives and the carriages in which the passengers were seated, and they were utterly demolished; but for this fortunate circumstance the Thorpe collision might well have proved the most disastrous of all railroad accidents. As it was, the men on both the locomotives were instantly killed, together with seventeen passengers, and four other passengers subsequently died of their injuries; making a total of twenty-five deaths, besides fifty cases of injury.

It would be difficult to conceive of a more violent collision than that which has just been described; and yet, as curiously illustrating the rapidity with

which the force of the most severe shock is expended, it is said that two gentlemen in the last carriage of one of the trains, finding it at a sudden standstill close to the place to which they were going, supposed it had stopped for some unimportant cause and concluded to take advantage of a happy chance which left them almost at the doors of their homes. They accordingly got out and hurried away in the rain, learning only the next morning of the catastrophe in which they had been unconscious participants.

The collision at Thorpe occurred in September, 1874. Seven months later, on the 4th of April, 1875, there was an accident similar to it in almost every respect, except fatality, on the Burlington & Missouri road in Iowa. In this case the operator at Tyrone had telegraphic orders to hold the east-bound passenger express at that point to meet the west-bound passenger express. This order he failed to deliver, and the train accordingly at once went on to the usual passing place at the next station. It was midnight and intensely dark, with a heavy mist in the air which at times thickened to rain. Both of the trains approaching each other were made up in the way usual with through night trains on the great western lines, and consisted of locomotives, baggage and smoking cars, behind which were the ordinary passenger cars of the company followed by several heavy Pullman sleeping coaches. Those in charge of the east-bound

train, knowing that it was behind time, were running it rapidly, so as to delay as little as possible the west-bound train, which, having received the order to pass at Tyrone was itself being run at speed. Both trains were thus moving at some thirty-five miles an hour, when suddenly in rounding a sharp curve they came upon each other. Indeed so close were they that the west-bound engineer had no time in which to reverse, but, jumping straight from the gangway, he afterwards declared that the locomotives came together before he reached the ground. The engineer of the east-bound train succeeded both in reversing his locomotive and in applying his air-brake, but after reversal the throttle flew open. The trains came together, therefore, as at Thorpe, with their momentum practically unchecked, and with such force that the locomotives were completely demolished, the boilers of the two, though on the same line of rails, actually, in some way, passing each other. The baggage-cars were also destroyed, and the smoking cars immediately behind them were more or less damaged, but the remaining coaches of each train stood upon the tracks so wholly uninjured that four hours later, other locomotives having been procured but the track being still blocked, the passengers were transferred from one set of cars to the other, and in them were carried to their destinations. So admirably did Miller's construction serve its purpose in this case, that, while the superintendent of the road, who happened to be in the

rear sleeping car of one of the trains, merely reported that he "felt the shock quite sensibly," passengers in the rear coaches of the other train hardly felt it at all.

At Tyrone the wrecks of the trains caught fire from the stoves thrown out of the baggage cars and from the embers from the fire-boxes of the locomotives, but the flames were speedily extinguished. Of the train hands three were killed and two injured, but no passenger was more than shaken or slightly bruised. This was solely due to strength of car construction. Heavy as the shock was,—so heavy that in the similar case at Thorpe the carriages were crushed like nut-shells under it,—the resisting power was equal to it. The failure of appliances at one point in the operation of the road was made good by their perfection at another.

CHAPTER VIII.

OIL-TANK ACCIDENTS.

SIMILAR in some of its more dramatic features to the Versailles accident, though originating from a wholly different cause, was the Abergele disaster, which at the time occupied the attention of the British public to the exclusion of everything else. It occurred in 1868, and to the "Irish mail," perhaps the most famous train which is run in England, if, indeed, not in the world. Leaving London shortly after 7 A.M., the Irish mail was then timed to make the distance to Chester, 166 miles, in four hours and eighteen minutes, or at the rate of 40 miles an hour. For the next 85 miles, completing the run to Holyhead, the speed was somewhat increased, two hours and five minutes only being allowed for it. Abergele is a point on the sea-coast of Wales, nearly midway between Chester and Holyhead. On the day of the accident, August 20, 1868, the Irish mail left Chester as usual. It was made up of thir-

teen carriages in all, which were occupied, as the carriages of that train usually were, by a large number of persons whose names at least were widely known. Among these, on this particular occasion, was the Duchess of Abercorn, wife of the then Lord Lieutenant of Ireland, with five children. Under the running arrangements of the London & North Western road a freight, or as it is there called a goods train, left Chester half an hour before the mail, and was placed upon the siding at Llanddulas, a station about a mile and a half beyond Abergele, to allow the mail to pass. From Abergele to Llanddulas the track ascended by a gradient of some sixty feet to the mile. On the day of the accident it chanced that certain wagons between the engine and the rear end of the goods train had to be taken out to be left at Llanddulas, and in doing this it became necessary to separate the train and to leave five or six of the last wagons in it standing on the tracks of the main line, while those which were to be left were backed onto a siding. The employé, whose duty it was, neglected to set the brakes on the wagons thus left standing, and consequently when the engine and the rest of the train returned for them, the moment they were touched and before a coupling could be effected, the jar set them in motion down the incline towards Abergele. They started so slowly that a brakeman of the train ran after them, fully expecting to catch and stop them, but as they went down the grade they soon out-

stripped him and it became clear that there was nothing to check them until they should meet the Irish mail, then almost due. It also chanced that the cars thus set in motion were oil cars.

The track of the North Western road between Abergele and Llanddulas runs along the sides of the picturesque Welsh hills, which rise up to the south; while to the north there stretches out a wide expanse of sea. The mail train was skirting the hills and laboring up the grade at a speed of thirty miles an hour, when its engineer suddenly became aware of the loose wagons coming down upon it around the curve, and then but a few yards off. Seeing that they were oil cars he almost instinctively sprang from his locomotive, and was thrown down by the impetus and rolled to the side of the road-bed. Picking himself up, bruised but not seriously hurt, he saw that the collision had already taken place, that the tender had ridden directly over the engine, that the colliding cars were demolished, and that the foremost carriages of the train were already on fire. Running quickly to the rear of the train he succeeded in uncoupling six carriages and a van, which were drawn away from the rest, before the flames extended to them, by an engine which most fortunately was following the train. All the other carriages were utterly destroyed, and every person in them perished.

The Abergele was probably the solitary instance of a railroad accident in which but a single sur-

vivor sustained any injury. There was no maiming. It was death or entire escape. The collision was not a particularly severe one, and the engineer of the mail train especially stated that at the moment it occurred the loose cars were still moving so slowly that he would not have sprung from his engine had he not seen that they were loaded with oil. The very instant the collision took place, however, the fluid seemed to ignite and to flash along the train like lightning, so that it was impossible to approach a carriage when once it caught fire. The fact was that the oil in vast quantities was spilled upon the track and ignited by the fire of the locomotive, and then the impetus of the mail train forced all of its leading carriages into the dense mass of smoke and flame. All those who were present concurred in positively stating that not a cry, nor a moan, nor a sound of any description was heard from the burning carriages, nor did any one in them apparently make an effort to escape.

The most graphic description of this extraordinary and terrible catastrophe was that given by the Marquis of Hamilton, the eldest son of the Duke of Abercorn whose wife and family, fortunately for themselves, occupied one of those rear carriages which were unshackled and saved. In this account the Marquis of Hamilton said:—"We were startled by a collision and a shock which, though not very severe, were sufficient to throw every one against his opposite neighbor. I immediately jumped out

of the carriage, when a fearful sight met my view. Already the whole of the three passengers' carriages in front of ours, the vans, and the engine were enveloped in dense sheets of flame and smoke, rising fully twenty feet high, and spreading out in every direction. It was the work of an instant. No words can convey the instantaneous nature of the explosion and conflagration. I had actually got out almost before the shock of the collision was over, and this was the spectacle which already presented itself. Not a sound, not a scream, not a struggle to escape, not a movement of any sort was apparent in the doomed carriages. It was as though an electric flash had at once paralyzed and stricken every one of their occupants. So complete was the absence of any presence of living or struggling life in them that as soon as the passengers from the other parts of the train were in some degree recovered from their first shock and consternation, it was imagined that the burning carriages were destitute of passengers; a hope soon changed into feelings of horror when their contents of charred and mutilated remains were discovered an hour afterward. From the extent, however, of the flames, the suddenness of the conflagration, and the absence of any power to extricate themselves, no human aid would have been of any assistance to the sufferers, who, in all probability, were instantaneously suffocated by the black and fetid smoke peculiar to paraffine, which rose in volumes around the spreading flames."

Though the collision took place before one o'clock, in spite of the efforts of a large gang of men who were kept throwing water on the tracks, the perfect sea of flame which covered the line for a distance of some forty or fifty yards could not be extinguished until nearly eight o'clock in the evening; for the petroleum had flowed down into the ballasting of the road, and the rails themselves were red-hot. It was therefore small occasion for surprise that, when the fire was at last gotten under, the remains of those who lost their lives were in some cases wholly undistinguishable, and in others almost so. Among the thirty-three victims of the disaster the body of no single one retained any traces of individuality; the faces of all were wholly destroyed, and in no case were there found feet, or legs, or anything at all approaching to a perfect head. Ten corpses were finally identified as those of males, and thirteen as those of females, while the sex of ten others could not be determined. The body of one passenger, Lord Farnham, was identified by the crest on his watch; and, indeed, no better evidence of the wealth and social position of the victims of this accident could have been asked for than the collection of articles found on its site. It included diamonds of great size and singular brilliancy; rubies, opals, emeralds, gold tops of smelling-bottles, twenty-four watches, of which but two or three were not gold, chains, clasps of bags, and very many bundles of keys. Of these the diamonds

alone had successfully resisted the intense heat of the flame; the settings were nearly all destroyed.

Of the causes of this accident little need or can be said. No human appliances, no more ingenious brakes or increased strength of construction, could have averted it or warded off its consequences once it was inevitable. It was occasioned primarily by two things, the most dangerous and the most difficult to reach of all the many sources of danger against which those managing railroads have unsleepingly to contend:—a somewhat defective discipline, aggravated by a little not unnatural carelessness. The rule of the company was specific that all the wagons of every goods train should be out of the way and the track clear at least ten minutes before a passenger train was due; but in this case shunting was going actively on when the Irish-mail was within a mile and a half. A careless brakeman then forgot for once that he was leaving his wagons close to the head of an incline; a blow in coupling, a little heavier perhaps than usual, sufficed to set them in motion; and they happened to be loaded with oil.

A catastrophe strikingly similar to that at Abergele befell an express train on the Hudson River railroad, upon the night of the 6th of February, 1871. The weather for a number of days preceding the accident had been unusually cold, and it is to the suffering of employés incident to exposure, and the consequent neglect of precautions on their part,

that accidents are peculiarly due. On this night a freight train was going south, all those in charge of which were sheltering themselves during a steady run in the caboose car at its rear end. Suddenly, when near a bridge over Wappinger's Creek, not far from New Hamburg, they discovered that a car in the centre of the train was off the track. The train was finally stopped on the bridge, but in stopping it other cars were also derailed, and one of these, bearing on it two large oil tanks, finally rested obliquely across the bridge with one end projecting over the up track. Hardly had the disabled train been brought to a stand-still, when, before signal lanterns could in the confusion incident to the disaster be sent out, the Pacific express from New York, which was a little behind its time, came rapidly along. As it approached the bridge, its engineer saw a red lantern swung, and instantly gave the signal to apply the brakes. It was too late to avoid the collision; but what ensued had in it, so far as the engineer was concerned, an element of the heroic, which his companion, the fireman of the engine, afterwards described on the witness stand with a directness and simplicity of language which exceeded all art. The engineer's name was Simmons, and he was familiarly known among his companions as "Doc." His fireman, Nicholas Tallon, also saw the red light swung on the bridge, and called out to him that the draw was open. In reply Simmons told him to spring the patent brake, which he did, and

by this time they were alongside of the locomotive of the disabled train and running with a somewhat slackened speed. Tallon had now got out upon the step of the locomotive, preparatory to springing off, and turning asked his companion if he also proposed to do the same:—"'Doc' looked around at me but made no reply, and then looked ahead again, watching his business; then I jumped and rolled down on the ice in the creek; the next I knew I heard the crash and saw the fire and smoke." The next seen of "Doc" Simmons, he was dragged up days afterwards from under his locomotive at the bottom of the river. But it was a good way to die. He went out of the world and of the sight of men with his hand on the lever, making no reply to the suggestion that he should leave his post, but "looking ahead and watching his business."

Dante himself could not have imagined a greater complication of horrors than then ensued: liquid fire and solid frost combined to make the work of destruction perfect. The shock of the collision broke in pieces the oil car, igniting its contents and flinging them about in every direction. In an instant bridge, river, locomotive, cars, and the glittering surface of the ice were wrapped in a sheet of flame. At the same time the strain proved too severe for the trestlework, which gave way, precipitating the locomotive, tender, baggage cars, and one passenger car onto the ice, through which they instantly crushed and sank deep out of sight beneath

the water. Of the remaining seven cars of the passenger train, two, besides several of the freight train, were destroyed by fire, and shortly, as the supports of the remaining portions of the bridge burned away, the superstructure fell on the half-submerged cars in the water and buried them from view.

Twenty-one persons lost their lives in this disaster, and a large number of others were injured; but the loss of life, it will be noticed, was only two-thirds of that at Abergele. The New Hamburg catastrophe also differed from that at Abergele in that, under its particular circumstances, it was far more preventable, and, indeed, with the appliances since brought into use it would surely be avoided. The modern train-brake had, however, not then been perfected, so that even the hundred rods at which the signal was seen did not afford a sufficient space in which to stop the train.

CHAPTER IX.

DRAW-BRIDGE DISASTERS.

It is difficult to see how on double track roads, where the occurrence of an accident on one line of tracks is always liable to instantly "foul" the other line, it is possible to guard against contingencies like that which occurred at New Hamburg. At the time, as is usual in such cases, the public indignation expended itself in vague denunciation of the Hudson River Railroad Company, because the disaster happened to take place upon a bridge in which there was a draw to permit the passage of vessels. There seemed to be a vague but very general impression that draw-bridges were dangerous things, and, because other accidents due to different causes had happened upon them, that the occurrence of this accident, from whatever cause, was in itself sufficient evidence of gross carelessness. The fact was that not even the clumsy Connecticut rule, which compels the stopping of all trains before entering on any

draw-bridge, would have sufficed to avert the New Hamburg disaster, for the river was then frozen and the draw was not in use, so that for the time being the bridge was an ordinary bridge; and not even in the frenzy of crude suggestions which invariably succeeds each new accident was any one ever found ignorant enough to suggest the stopping of all trains before entering upon every bridge, which, as railroads generally follow water-courses, would not infrequently necessitate an average of one stop to every thousand feet or so. Only incidentally did the bridge at New Hamburg have anything to do with the disaster there, the essence of which lay in the sudden derailment of an oil car immediately in front of a passenger train running in the opposite direction and on the other track. Of course, if the derailment had occurred long enough before the passenger train came up to allow the proper signals to be given, and this precaution had been neglected, then the disaster would have been due, not to the original cause, but to the defective discipline of the employés. Such does not appear to have been the case at New Hamburg, nor was that disaster by any means the first due to derailment and the throwing of cars from one track in front of a train passing upon the other;—nor will it be the last. Indeed, an accident hardly less destructive, arising from that very cause, had occurred only eight months previous in England, and resulted in eighteen deaths and more than fifty cases of injury.

A goods train made up of a locomotive and twenty-nine wagons was running at a speed of some twenty miles an hour on the Great Northern road, between Newark and Claypole, about one hundred miles from London, when the forward axle under one of the wagons broke. As a result of the derailment which ensued the train became divided, and presently the disabled car was driven by the pressure behind it out of its course and over the interval, so that it finally rested partly across the other track. At just this moment an excursion train from London, made up of twenty-three carriages and containing some three hundred and forty passengers, came along at a speed of about thirty-five miles an hour. It was quite dark, and the engineer of the freight train waved his arm as a signal of danger; one of the guards, also, showed a red light with his hand lantern, but his action either was not seen or was misunderstood, for without any reduction of speed being made the engine of the excursion train plunged headlong into the disabled goods wagon. The collision was so violent as to turn the engine aside off the track and cause it to strike the stone pier of a bridge near by, by which it was flung completely around and then driven up the slope of the cutting, where it toppled over like a rearing horse and fell back into the roadway. The tender likewise was overturned; but not so the carriages. They rushed along holding to the track, and the side of each as it passed was ripped and

torn by the projecting end of the goods wagon. Of the twenty-three carriages and vans in the train scarcely one escaped damage, while the more forward ones were in several cases lifted one on top of the other or forced partly up the slope of the cutting, whence they fell back again, crushing the passengers beneath them.

This accident occurred on the 21st of June, 1870; it was very thoroughly investigated by Captain Tyler on behalf of the Board of Trade, with the apparent conclusion that it was one which could hardly have been guarded against. The freight cars, the broken axle of which occasioned the disaster, did not belong to the Great Northern company, and the wheels of the train had been properly examined by viewing and tapping at the several stopping-places; the flaw which led to the fracture was, however, of such a nature that it could have been detected only by the removal of the wheel. It did not appear that the employés of the company had been guilty of any negligence; and it was difficult to avoid the conclusion that the accident was due to one of those defects to which the results of even the most perfect human workmanship must ever remain liable, and this had revealed itself under exactly those conditions which must involve the most disastrous consequences.

The English accident did, however, establish one thing, if nothing else; it showed the immeasurable superiority of the system of investigation pursued

in the case of railroad accidents in England over that pursued in this country. There a trained expert after the occurrence of each disaster visits the spot and sifts the affair to the very bottom, locating responsibility and pointing out distinctly the measures necessary to guard against its repetition. Here the case ordinarily goes to a coroner's jury, the findings of which as a rule admirably sustain the ancient reputation of that august tribunal. It is absolutely sad to follow the course of these investigations, they are conducted with such an entire disregard of method and lead to such inadequate conclusions. Indeed, how could it be otherwise?—The same man never investigates two accidents, and, for the one investigation he does make, he is competent only in his own esteem.

Take the New Hamburgh accident as an example. Rarely has any catastrophe merited a more careful investigation, and few indeed have ever called forth more ill-considered criticism or crude suggestions. Almost nothing of interest respecting it was elicited at the inquest, and now no reliable criticism can be ventured upon it. The question of responsibility in that case, and of prevention thereafter, involved careful inquiry into at least four subjects:—First, the ownership and condition of the freight car, the fractured axle of which occasioned the disaster, together with the precautions taken by the company, usually and in this particular case, to test the wheels of freight cars moving over its road, espe-

pecially during times of severe cold.—Second, the conduct of those in charge of the freight train immediately preceding and at the time of the accident; was the fracture of the axle at once noticed and were measures taken to stop the train, or was the derailment aggravated by neglect into the form it finally took?—Third, was there any neglect in signaling the accident on the part of those in charge of the disabled train, and how much time elapsed between the accident and the collision?—Fourth, what, if any, improved appliances would have enabled those in charge of either train to have averted the accident?—and what, if any, defects either in the rules or the equipment in use were revealed?

No satisfactory conclusion can now be arrived at upon any of these points, though the probabilities are that with the appliances since introduced the train might have been stopped in time. In this case, as in that at Claybridge, the coroner's jury returned a verdict exonerating every one concerned from responsibility, and very possibly they were justified in so doing; though it is extremely questionable whether Captain Tyler would have arrived at a similar conclusion. There is a strong probability that the investigation went off, so to speak, on a wholly false issue,—turned on the draw-bridge frenzy instead of upon the question of care. So far as the verdict declared that the disaster was due to a collision between a passenger train and a derailed oil car, and not to the existence of a draw in the bridge

on which it happened to occur, it was, indeed, entitled to respect, and yet it was on this very point that it excited the most criticism. Loud commendation was heard through the press of the Connecticut law, which had been in force for twenty years, and, indeed, still is in force there, under which all trains are compelled to come to a full stop before entering on any bridge which has a draw in it,—a law which may best be described as a useless nuisance. Yet the grand jury of the Court of Oyer and Terminer of New York city even went so far as to recommend, in a report made by it on the 23d of February, 1871,—sixteen days after the accident,—the passage by the legislature then in session at Albany of a similar legal absurdity. Fortunately better counsels prevailed, and, as the public recovered its equilibrium, the matter was allowed to drop.

The Connecticut law in question, however, originated in an accident which at the time had startled and shocked the community as much even as that at Versailles did before or that at Abergele has since done. It occurred to an express train on the New York & New Haven road at Norwalk, in Connecticut, on the 6th of May, 1853.

CHAPTER X.

THE NORWALK ACCIDENT.

THE railroad at Norwalk crosses a small inlet of Long Island Sound by means of a draw-bridge, which is approached from the direction of New York around a sharp curve. A ball at the mast-head was in 1853 the signal that the draw was open and the bridge closed to the passage of trains. The express passenger train for Boston, consisting of a locomotive and two baggage and five passenger cars, containing about one hundred and fifty persons, left New York as usual at eight o'clock that morning. The locomotive was not in charge of its usual engine-driver but of a substitute named Tucker; a man who some seven years before had been injured in a previous collision on the same road, for which he did not appear to have been in any way responsible, but who had then given up his position and gone to California, whence he had recently returned and was now again an applicant for an engineer's situation. This was his

third trip over the road, as substitute. In approaching the bridge at Norwalk he apparently wholly neglected to look for the draw-signal. He was running his train at about the usual rate of speed, and first became aware that the draw was open when within four hundred feet of it and after it had become wholly impossible to stop the train in time. He immediately whistled for brakes and reversed his engine, and then, without setting the brake on his tender, both he and the fireman sprang off and escaped with trifling injuries. The train at this time did not appear to be moving at a speed of over fifteen miles an hour. The draw was sixty feet in width; the water in the then state of the tide was about twelve feet deep, and the same distance below the level of the bridge. Although the speed of the train had been materially reduced, yet when it came to the opening it was still moving with sufficient impetus to send its locomotive clean across the sixty foot interval and to cause it to strike the opposite abutment about eight feet below the track; it then fell heavily to the bottom. The tender lodged on top of the locomotive, bottom up and resting against the pier, while on top of this again was the first baggage car. The second baggage car, which contained also a compartment for smokers, followed, but in falling was canted over to the north side of the draw in such a way as not to be wholly submerged, so that most of those in it were saved. The first passenger car next plunged into

the opening; its forward end crushed in, as it fell against the baggage car in front of it, while its rear end dropped into the deep water below; and on top of it came the second passenger car, burying the passengers in the first beneath the *débris*, and itself partially submerged. The succeeding or third passenger car, instead of following the others, broke in two in the middle, the forward part hanging down over the edge of the draw, while the rear of it rested on the track and stayed the course of the remainder of the train. Including those in the smoking compartment more than a hundred persons were plunged into the channel, of whom forty-six lost their lives, while some thirty others were more or less severely injured. The killed were mainly among the passengers in the first car; for, in falling, the roof of the second car was split open, and it finally rested in such a position that, as no succeeding car came on top of it, many of those in it were enabled to extricate themselves; indeed, more than one of the passengers in falling were absolutely thrown through the aperture in the roof, and, without any volition on their part, were saved with unmoistened garments.

Shocking as this catastrophe was, it was eclipsed in horror by another exactly similar in character, though from the peculiar circumstances of the case it excited far less public notice, which occurred eleven years later on the Grand Trunk railway of Canada. In this case a large party of emigrants, over 500 in number and chiefly Poles, Germans and

Norwegians of the better class, had landed at Quebec and were being forwarded on a special train to their destination in the West. With their baggage they filled thirteen cars. The Grand Trunk on the way to Montreal crosses the Richelieu river at Belœil by an iron bridge, in the westernmost span of which was a draw over the canal, some 45 feet below it Both by law and under the running rules of the road all trains were to come to a dead stand on approaching the bridge, and to proceed only when the safety signal was clearly discerned. This rule, however, as it appeared at the subsequent inquest, had been systematically disobeyed, it having been considered sufficient if the train was "slowed down." In the present case, however—the night of June 29, 1864,—though the danger signal was displayed and in full sight for a distance of 1,600 feet, the engine-driver, unfamiliar with the road and its signals, failed to see it, and, without slowing his train even, ran directly onto the bridge. He became aware of the danger when too late to stop. The draw was open to permit the passage of a steamer with six barges in tow, one of which was directly under the opening. The whole train went through the draw, sinking the barge and piling itself up in the water on top of it. The three last cars, falling on the accumulated wreck, toppled over upon the west embankment and were thus less injured than the others. The details of the accident were singularly distressing. "As soon as possible a strong cable was

attached to the upper part of the piling, and by this means two cars, the last of the ill-fated train, were dragged onto the wharf under the bridge. Their removal revealed a horrible sight. A shapeless blue mass of hands and heads and feet protruded among the splinters and frame-work, and gradually resolved itself into a closely-packed mass of human beings, all ragged and bloody and dinted from crown to foot with blue bruises and weals and cuts inflicted by the ponderous iron work, the splinters and the enormous weight of the train. * * * A great many of the dead had evidently been asleep; the majority of them had taken off their boots and coats in the endeavor to make themselves as comfortable as possible. They lay heaped upon one another like sacks, dressed in the traditional blue clothing of the German people. * * * A child was got at and removed nine hours after the accident, being uninjured in its dead mother's arms."

The accident happened at 2 A.M, and before sundown of the next day 86 bodies had been taken out of the canal; others were subsequently recovered, and yet more died from their hurts. The injured were numbered by hundreds. It was altogether a disaster of the most appalling description, in extenuation of which nothing was to be said. It befell, however, a body of comparatively friendless emigrants, and excited not a tithe of the painful interest which yet attaches to the similar accident to the Boston express at Norwalk.

These terrible disasters were both due, not alone to the carelessness of the two engine-drivers, but to the use of a crude and inadequate system of signals. It so happened, however, that the legislature of Connecticut was unfortunately in session at the time of the Norwalk disaster, and consequently the public panic and indignation took shape in a law compelling every train on the railroads of that state to come to a dead stand-still before entering upon any bridge in which there was a draw. This law is still in force, and from time to time, as after the New Hamburg catastrophe, an unreasoning clamor is raised for it in other states. In point of fact it imposes a most absurd, unnecessary and annoying delay on travel, and rests upon the Connecticut statute book a curious illustration of what usually happens when legislators undertake to incorporate running railroad regulations into the statutes-at-large. It is of a par with another law, which has for more than twenty-five years been in force in Connecticut's sister state of Massachusetts, compelling in all cases where the tracks of different companies cross each other at a level the trains of each company to stop before reaching the crossing, and then to pass over it slowly. The danger of collision at crossings is undoubtedly much greater than that of going through open draws. Precautions against danger in each case are unquestionably proper and they cannot be too perfect, but to have recourse to stopping either in the one case or

the other simply reveals an utter ignorance of the great advance which has been made in railroad signals and the science of interlocking. In both these cases it is, indeed, entitled to just about the same degree of respect as would be a proposal to recur to pioneer engines as a means of preventing accidents to night trains.

The machinery by means of which both draws and grade crossings can be protected, will be referred to in another connection,* meanwhile it is a curious fact that neither at grade crossings nor at draws has the mere stopping of trains proved a sufficient protection. Several times in the experience of Massachusetts' roads have those in charge of locomotives, after stopping and while moving at a slow rate of speed, actually run themselves into draws with their eyes open, and afterwards been wholly unable to give any satisfactory explanation of their conduct. But the insufficiency of stopping as a reliable means of prevention was especially illustrated in the case of an accident which occurred upon the Boston & Maine railroad on the morning of the 21st of November, 1862, when the early local passenger train was run into the open draw of the bridge almost at the entrance to the Boston station. It so happened that the train had stopped at the Charlestown station just before going onto the bridge, and at the time the accident occurred was moving at a speed scarcely faster than

* Chapters XVII and XVIII.

a man could walk; and yet the locomotive was entirely submerged, as the water at that point is deep, and the only thing which probably saved the train was that the draw was so narrow and the cars were so long that the foremost one lodged across the opening, and its forward end only was beneath the water. At the rate at which the train was moving the resistance thus offered was sufficient to stop it, though, even as it was, no less than six persons lost their lives and a much larger number were more or less injured. Here all the precautions imposed by the Connecticut law were taken, and served only to reveal the weak point in it. The accident was due to the neglect of the corporation in not having the draw and its system of signals interlocked in such a way that the movement of the one should automatically cause a corresponding movement of the other; and this neglect in high quarters made it possible for a careless employé to open the draw on a particularly dark and foggy morning, while he forgot at the same time to shift his signals. An exactly similar instance of carelessness on the part of an employé resulted in the derailment of a train upon the Long Branch line of the Central Road of New Jersey at the Shrewsbury river draw on August 9, 1877. In this case the safety signal was shown while the draw fastening had been left unsecured. The jar of the passing train threw the draw slightly open so as to disconnect the tracks; thus causing the derailment of the train, which sub-

sequently plunged over the side of the bridge. Fortunately the tide was out, or there would have been a terrible loss of life; as it was, some seventy persons were injured, five of whom subsequently died. This accident also, like that on the Boston & Maine road in 1862, very forcibly illustrated the necessity of an interlocking apparatus. The safety signal was shown before the draw was secured, which should have been impossible.

Prior to the year 1873 there is no consecutive record of this or any other class of railroad accidents occurring in America, but during the six years 1873–8 there occurred twenty-one cases of minor disaster at draws, three only of them to passenger trains. Altogether, excluding the Shrewsbury river accident, these resulted in the death of five employés and injury to one other. No passenger was hurt. In Great Britain not a single case of disaster of any description has been reported as occurring at a drawbridge since the year 1870, when the present system of official Board of Trade reports was begun. The lesson clearly to be drawn from a careful investigation of all the American accidents reported would seem to be that a statute provision making compulsory the interlocking of all draws in railroad bridges with a proper and infallible system of signals might have claims on the consideration of an intelligent legislature; not so an enactment which compels the stopping of trains at points where danger is small, and makes no provision as respects other points where it is great.

CHAPTER XI.

BRIDGE ACCIDENTS.

GREAT as were the terrors inspired by the Norwalk disaster in those comparatively early days of railroad experience, and deep as the impression on the public memory must have been to leave its mark on the statute book even to the present time, that and the similar disaster at the Richelieu river are believed to have been the only two of great magnitude which have occurred at open railroad draws. That this should be so is well calculated to excite surprise, for the draw-bridge precautions against accident in America are wretchedly crude and inadequate, amounting as a rule to little more than the primitive balls and targets by day and lanterns by night, without any system of alarms or interlocking. Electricity as an adjunct to human care, or a corrective rather of human negligence, is almost never used; and, in fact, the chief reliance is still on the vigilance of engine-drivers. But, if acci-

dents at draws have been comparatively rare and unattended with any considerable loss of life, it has been far otherwise with the rest of the structures of which the draw forms a part. Bridge accidents in fact always have been, and will probably always remain, incomparably the worst to which travel by rail is exposed. It would be impossible for corporations to take too great precautions against them, and that the precautions taken are very great is conclusively shown by the fact that, with thousands of bridges many times each day subjected to the strain of the passage at speed of heavy trains, so very few disasters occur. When they do occur, however, the lessons taught by them are, though distinct enough, apt to be in one important respect of a far less satisfactory character than those taught by collisions. In the case of these last the great resultant fact speaks for itself. The whole community knows when it sees a block system, or a stronger car construction, or an improved train brake suddenly introduced that the sacrifice has not been in vain—that the lesson has been learned. It is by no means always so in the case of accidents on bridges. With these the cause of disaster is apt to be so scientific in its nature that it cannot even be described, except through the use of engineering terms which to the mass of readers are absolutely incomprehensible. The simplest of railroad bridges is an inexplicable mystery to at least ninety-nine persons out of each hundred.

Even when the cause of disaster is understood, the precautions taken against its recurrence cannot be seen. From the nature of the case they must consist chiefly of a better material, or a more scientific construction, or an increased watchfulness on the part of officials and subordinates. This, however, is not apparent on the surface, and, when the next accident of the same nature occurs, the inference, as inevitable as it is usually unjust, is at once drawn that the one which preceded it had been productive of no results. The truth of this was strongly illustrated by the two bridge accidents which happened, the one at Ashtabula, Ohio, on the 29th of December, 1876, and the other at Tariffville, Connecticut, on the 15th of January, 1878.

There has been no recent disaster which combined more elements of horror or excited more widespread public emotion than that at Ashtabula bridge. It was, indeed, so terrible in its character and so heart-rending in its details, that for the time being it fairly divided the attention of the country with that dispute over the presidential succession, then the subject uppermost in the minds of all. A blinding north-easterly snow-storm, accompanied by a heavy wind, prevailed throughout the day which preceded the accident, greatly impeding the movement of trains. The Pacific express over the Michigan Southern & Lake Shore road had left Erie, going west, considerably behind its time, and had been started only with

great difficulty and with the assistance of four locomotives. It was due at Ashtabula at about 5.30 o'clock P.M., but was three hours late, and, the days being then at their shortest, when it arrived at the bridge which was the scene of the accident the darkness was so great that nothing could be seen through the driving snow by those on the leading locomotive even for a distance of 50 feet ahead. The train was made up of two heavy locomotives, four baggage, mail and express cars, one smoking car, two ordinary coaches, a drawing-room car and three sleepers, being in all two locomotives and eleven cars, in the order named, containing, as nearly as can be ascertained, 190 human beings, of whom 170 were passengers. Ashtabula bridge is situated only about 1,000 feet east of the station of the same name, and spans a deep ravine, at the bottom of which flows a shallow stream, some two or three feet in depth, which empties into Lake Erie a mile or two away. The bridge was an iron Howe truss of 150 feet span, elevated 69 feet above the bottom of the ravine, and supported at either end by solid masonwork abutments. It had been built some fourteen years. As the train approached the bridge it had to force its way through a heavy snow-drift, and, when it passed onto it, it was moving at a speed of some twelve or fourteen miles an hour. The entire length of the bridge afforded space only for two of the express cars at most in addition to the locomotives, so that when the wheels of the leading locomotive rested

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on the western abutment of the bridge nine of the eleven cars which made up the train, including all those in which there were passengers, had yet to reach its eastern end. At the instant when the train stood in this position, the engineer of the leading locomotive heard a sudden cracking sound apparently beneath him, and thought he felt the bridge giving way. Instantly pulling the throttle valve wide open, his locomotive gave a spring forward and, as it did so, the bridge fell, the rear wheels of his tender falling with it. The jerk and impetus of the locomotive, however, sufficed to tear out the coupling, and as his tender was dragged up out of the abyss onto the track, though its rear wheels did not get upon the rails, the frightened engineer caught a fearful glimpse of the second locomotive as it seemed to turn and then fall bottom upwards into the ravine. The bridge had given way, not at once but by a slowly sinking motion, which began at the point where the pressure was heaviest, under the two locomotives and at the west abutment. There being two tracks, and this train being on the southernmost of the two, the southern truss had first yielded, letting that side of the bridge down, and rolling, as it were, the second locomotive and the cars immediately behind it off to the left and quite clear of a straight line drawn between the two abutments; then almost immediately the other truss gave way and the whole bridge fell, but in doing so swung slightly to the

right. Before this took place the entire train with the exception of the last two sleepers had reached the chasm, each car as it passed over falling nearer than the one which had preceded it to the east abutment, and finally the last two sleepers came, and, without being deflected from their course at all, plunged straight down and fell upon the wreck of the bridge at its east end. It was necessarily all the work of a few seconds.

At the bottom of the ravine the snow lay waist deep and the stream was covered with ice some eight inches in thickness. Upon this were piled up the fallen cars and engine, the latter on top of the former near the western abutment and upside down. All the passenger cars were heated by stoves. At first a dead silence seemed to follow the successive shocks of the falling mass. In less than two minutes, however, the fire began to show itself and within fifteen the holocaust was at its height. As usual, it was a mass of human beings, all more or less stunned, a few killed, many injured and helpless, and more yet simply pinned down to watch, in the possession as full as helpless of all their faculties, the rapid approach of the flames. The number of those killed outright seems to have been surprisingly small. In the last car, for instance, no one was lost. This was due to the energy and presence of mind of the porter, a negro named Steward, who, when he felt the car resting firmly on its side, broke a window and crawled through it, and then passed

along breaking the other windows and extricating the passengers until all were gotten out. Those in the other cars were far less fortunate. Though an immediate alarm had been given in the neighboring town, the storm was so violent and the snow so deep that assistance arrived but slowly. Nor when it did arrive could much be effected. The essential thing was to extinguish the flames. The means for so doing were close at hand in a steam pump belonging to the railroad company, while an abundance of hose could have been procured at another place but a short distance off. In the excitement and agitation of the moment contradictory orders were given, even to forbidding the use of the pump, and practically no effort to extinguish the fire was made. Within half an hour of the accident the flames were at their height, and when the next morning dawned nothing remained in the ravine but a charred and undistinguishable mass of car trucks, brake-rods, twisted rails and bent and tangled bridge iron, with the upturned locomotive close to the west abutment.

In this accident some eighty persons are supposed to have lost their lives, while over sixty others were injured. The exact number of those killed can never be known, however, as more than half of those reported were utterly consumed in the fire; indeed, even of the bodies recovered scarcely one half could be identified. Of the cause of the disaster much was said at the time in language most un-

necessarily scientific;—but little was required to be said. It admitted of no extenuation. An iron bridge, built in the early days of iron-bridges,—that which fell under the train at Ashtabula, was faulty in its original construction, and the indications of weakness it had given had been distinct, but had not been regarded. That it had stood so long and that it should have given way when it did, were equally matters for surprise. A double track bridge, it should naturally have fallen under the combined pressure of trains moving simultaneously in opposite directions. The strain under which it yielded was not a particularly severe one, even taken in connection with the great atmospheric pressure of the storm then prevailing. It was, in short, one of those disasters, fortunately of infrequent occurrence, with which accident has little if any connection. It was due to original inexperience and to subsequent ignorance or carelessness, or possibly recklessness as criminal as it was fool-hardy.

Besides being a bridge accident, this was also a stove accident,—in this respect a repetition of Angola. One of the most remarkable features about it, indeed, was the fearful rapidity with which the fire spread, and the incidents of its spread detailed in the subsequent evidence of the survivors were simply horrible. Men, women and children, full of the instinct of self-preservation, were caught and pinned fast for the advancing flames, while those who tried to rescue them were driven back by the

heat and compelled helplessly to listen to their shrieks. It is, however, unnecessary to enter into these details, for they are but the repetition of an experience which has often been told, and they do but enforce a lesson which the railroad companies seem resolved not to learn. Unquestionably the time in this country will come when through trains will be heated from a locomotive or a heating-car. That time, however, had not yet come. Meanwhile the evidence would seem to show that at Ashtabula, as at Angola, at least two lives were sacrificed in the subsequent fire to each one lost in the immediate shock of the disaster.*

But a few days more than a year after the Ashtabula accident another catastrophe, almost exactly similar in its details, occurred on the Connecticut Western road. It is impossible to even estimate the amount of overhauling to which bridges throughout the country had in the meanwhile been subjected, or the increased care used in their exami-

* The Angola was probably the most impressively horrible of the many "stove accidents." That which occurred near Prospect, N. Y., upon the Buffalo, Corry & Pittsburgh road, on December 24, 1872, should not, however, be forgotten. In this case a trestle bridge gave way precipitating a passenger train some thirty feet to the bottom of a ravine, where the cars caught fire from the stoves. Nineteen lives were lost, mostly by burning. The Richmond Switch disaster of April 19, 1873, on the New York, Providence & Boston road was of the same character. Three passengers only were there burned to death, but after the disaster the flames rushed "through the car as quickly as if the wood had been a lot of hay," and, after those who were endeavoring to release the wounded and imprisoned men were driven away, their cries were for some time heard through the smoke and flame.

nation. All that can be said is that during the year 1877 no serious accident due to the inherent weakness of any bridge occcurred on the 70,000 miles of American railroad. Neither, so far as can be ascertained, was the Tariffville disaster to be referred to that cause. It happened on the evening of January 15, 1878. A large party of excursionists were returning from a Moody and Sankey revival meeting on a special train, consisting of two locomotives and ten cars. Half a mile west of Tariffville the railroad crosses the Farmington river. The bridge at this point was a wooden Howe truss, with two spans of 163 feet each. It had been in use about seven years and, originally of ample strength and good construction, there is no evidence that its strength had since been unduly impaired by neglect or exposure. It should, therefore, have sufficed to bear twice the strain to which it was now subjected. Exactly as at Ashtabula, however, the west span of the bridge gave way under the train just as the leading locomotives passed onto the tressel-work beyond it: the ice broke under the falling wreck, and the second locomotive with four cars were precipitated into the river. The remaining cars were stopped by the rear end of the third car, resting as it did on the centre pier of the bridge, and did not leave the rails. The fall to the surface of the ice was about ten feet. There was no fire to add to the horrors in this case, but thirteen persons were

crushed to death or drowned, and thirty-three others injured.*

Naturally the popular inference was at once drawn that this was a mere repetition of the Ashtabula experience,—that the fearful earlier lesson had been thrown away on a corporation either unwilling or not caring to learn. The newspapers far and wide resounded with ill considered denunciation, and the demand was loud for legislation of the crudest conceivable character, especially a law prohibiting the passage over any bridge of two locomotives attached to one passenger train. The fact, however, seems to be that, except in its superficial details, the Tariffville disaster had no features in common with that at Ashtabula; as nearly as can be ascertained it was due neither to the weak-

* Of the same general character with the Tariffville and Ashtabula accidents were those which occurred on November 1, 1855, upon the Pacific railroad of Missouri at the bridge over the Gasconade, and on July 27, 1875, upon the Northern Pacific at the bridge over the Mississippi near Brainerd. In the first of these accidents the bridge gave way under an excursion train, in honor of the opening of the road, and its chief engineer was among the killed. The train fell some thirty feet, and 22 persons lost their lives while over 50 suffered serious injuries.

At Brainerd the train,—a "mixed" one,—went down nearly 80 feet into the river. The locomotive and several cars had passed the span which fell, in safety, but were pulled back and went down on top of the train. There were but few passengers in it, of whom three were killed. In falling the caboose car at the rear of the train, in which most of the passengers were, struck on a pier and broke in two, leaving several passengers in it. In the case of the Gasconade, the disaster was due to the weakness of the bridge, which fell under the weight of the train. There is some question as to the Brainerd accident, whether it was occasioned by weakness of the bridge or the derailment upon it of a freight car.

ness nor to the overloading of the bridge. Though the evidence subsequently given is not absolutely conclusive on this point, the probabilities would seem to be that, while on the bridge, the second locomotive was derailed in some unexplained way and consequently fell on the stringers which yielded under the sudden blow. The popular impression, therefore, as to the bearing which the first of these two strikingly similar accidents had upon the last tended only to bring about results worse than useless. The bridge fell, not under the steady weight of two locomotives, but under the sudden shock incident to the derailment of one. The remedy, therefore, lay in the direction of so planking or otherwise guarding the floors of similar bridges that in case of derailment the locomotives or cars should not fall on the stringers or greatly diverge from the rails so as to endanger the trusses. On the other hand the suggestion of a law prohibiting the passage over bridges of more than one locomotive with any passenger train, while in itself little better than a legal recognition of bad bridge building, also served to divert public attention from the true lesson of the disaster. Another newspaper precaution, very favorably considered at the the time, was the putting of one locomotive, where two had to be used, at the rear end of the train as a pusher, instead of both in front. This expedient might indeed obviate one cause of danger, but it would do so only by substituting for it another which has been the fruitful

source of some of the worst railroad disasters on record.

* "The objectionable and dangerous practice also employed on some railways of assisting trains up inclines by means of pilot engines in the rear instead of in front, has led to several accidents in the past year and should be discontinued."—*General Report to the Board of Trade upon the Accidents on the Railways of Great Britain in* 1878, *p.* 15.

CHAPTER XII.

THE PROTECTION OF BRIDGES.

LONG, varied and terrible as the record of bridge disasters has become, there are, nevertheless, certain very simple and inexpensive precautions against them, which, altogether too frequently, corporations do not and will not take. At Ashtabula the bridge gave way. There was no derailment as there seems to have been at Tariffville. The sustaining power of a bridge is, of course, a question comparatively difficult of ascertainment. A fatal weakness in this respect may be discernable only to the eye of a trained expert. Derailment, however, either upon a bridge or when approaching it, is in the vast majority of cases a danger perfectly easy to guard against. The precautions are simple and they are not expensive, yet, taking the railroads of the United States as a whole, it may well be questioned whether the bridges at which they have been taken do not constitute the exception rather than the rule. Not

only is the average railroad superintendent accustomed to doing his work and running his road under a constant pressure to make both ends meet, which, as he well knows, causes his own daily bread to depend upon the economies he can effect; but, while he finds it hard work at best to provide for the multifarious outlays, long immunity from disaster breeds a species of recklessness even in the most cautious :—and yet the single mishap in a thousand must surely fall to the lot of some one. Many years ago the terrible results which must soon or late be expected wherever the consequences of a derailment on the approaches to a bridge are not securely guarded against, were illustrated by a disaster on the Great Western railroad of Canada, which combined many of the worst horrors of both the Norwalk and the New Hamburg tragedies; more recently the almost forgotten lesson was enforced again on the Vermont & Massachusetts road, upon the bridge over the Miller River, at Athol. The accident last referred to occurred on the 16th of June, 1870, but, though forcible enough as a reminder, it was tame indeed in comparison with the Des Jardines Canal disaster, which is still remembered though it happened so long ago as the 17th of March, 1857.

The Great Western railroad of Canada crossed the canal by a bridge at an elevation of about sixty feet. At the time of the accident there were some eighteen feet of water in the canal, though, as is

usual in Canada at that season, it was covered by ice some two feet in thickness. On the afternoon of the 17th of March as the local accommodation train from Hamilton was nearing the bridge, its locomotive, though it was then moving at a very slow rate of speed, was in some way thrown from the track and onto the timbers of the bridge. These it cut through, and then falling heavily on the string-pieces it parted them, and instantly pitched headlong down upon the frozen surface of the canal below, dragging after it the tender, baggage car and two passenger cars, which composed the whole train. There was nothing whatever to break the fall of sixty feet; and even then two feet of ice only intervened between the ruins of the train and the bottom of the canal eighteen feet below. Two feet of solid ice will afford no contemptible resistance to a falling body; the locomotive and tender crushed heavily through it and instantly sank out of sight. In falling the baggage car struck a corner of the tender and was thus thrown some ten yards to one side, and was followed by the first passenger car, which, turning a somersault as it went, fell on its roof and was crushed to fragments, but only partially broke through the ice, upon which the next car fell endwise, and rested in that position. That every human being in the first car was either crushed or drowned seems most natural; the only cause for astonishment is found in the fact that any one should have survived such a catastrophe,—a tumble of sixty feet on ice

as solid as a rock! Yet of four persons in the baggage car three went down with it, and not one of them was more than slightly injured. The engineer and fireman, and the occupants of the second passenger car, were less fortunate. The former were found crushed under the locomotive at the bottom of the canal; while of the latter ten were killed, and not one escaped severe injury. Very rarely indeed in the history of railroad accidents have so large a portion of those on the train lost their lives as in this case, for out of ninety persons sixty perished, and in the number was included every woman and child among the passengers, with a single exception.

There were two circumstances about this disaster worthy of especial notice. In the first place, as well as can now he ascertained in the absence of any trustworthy record of an investigation into causes, the accident was easily preventable. It appears to have been immediately caused by the derailment of a locomotive, however occasioned, just as it was entering on a swing draw-bridge. Thrown from the tracks, there was nothing in the flooring to prevent the derailed locomotive from deflecting from its course until it toppled over the ends of the ties, nor were the ties and the flooring apparently sufficiently strong to sustain it even while it held to its course. Under such circumstances the derailment of a locomotive upon any bridge can mean only destruction; it meant it then,

it means it now; and yet our country is to-day full of bridges constructed in an exactly similar way. To make accidents from this cause, if not impossible at least highly improbable, it is only necessary to make the ties and flooring of all bridges between the tracks and for three feet on either side of them sufficiently strong to sustain the whole weight of a train off the track and in motion, while a third rail, or strong truss of wood, securely fastened, should be laid down midway between the rails throughout the entire length of the bridge and its approaches. With this arrangement, as the flanges of the wheels are on the inside, it must follow that in case of derailment and a divergence to one side or the other of the bridge, the inner side of the flange will come against the central rail or truss just so soon as the divergence amounts to half the space between the rails, which in the ordinary gauge is two feet and four inches. The wheels must then glide along this guard, holding the train from any further divergence from its course, until it can be checked. Meanwhile, as the ties and flooring extend for the space of three feet outside of the track, a sufficient support is furnished by them for the other wheels. A legislative enactment compelling the construction of all bridges in this way, coupled with additional provisions for interlocking of draws with their signals in cases of bridges across navigable waters, would be open to objection that laws against dangers of accident by rail have almost invariably proved ineffective when

they were not absurd, but in itself, if enforced, it might not improbably render disasters like those at Norwalk and Des Jardines terrors of the past.

CHAPTER XIII.

CAR-COUPLINGS IN DERAILMENTS.

WHOLLY apart from the derailment, which was the real occasion of the Des Jardines disaster, there was one other cause which largely contributed to its fatality, if indeed that fatality was not in greatest part immediately due to it.

The question as to what is the best method of coupling together the several individual vehicles which make up every railroad train has always been much discussed among railroad mechanics. The decided weight of opinion has been in favor of the strongest and closest couplings, so that under no circumstances should the train separate into parts. Taking all forms of railroad accident together, this conclusion is probably sound. It is, however, at best only a balancing of disadvantages,—a mere question as to which practice involves the least amount of danger. Yet a very terrible demonstration that there are two sides to this as to most other questions

was furnished at Des Jardines. It was the custom on the Great Western road not only to couple the cars together in the method then in general use, but also, as is often done now, to connect them by heavy chains on each side of the centre coupling. Accordingly when the locomotive broke through the Des Jardines bridge, it dragged the rest of the train hopelessly after it. This certainly would not have happened had the modern self-coupler been in use, and probably would not have happened had the cars been connected only by the ordinary link and pins; for the train was going very slowly, and the signal for brakes was given in ample time to apply them vigorously before the last cars came to the opening, into which they were finally dragged by the dead weight before them and not hurried by their own momentum.

On the other hand, we have not far to go in search of scarcely less fatal disasters illustrating with equal force the other side of the proposition, in the terrible consequences which have ensued from the separation of cars in cases of derailment. Take, for instance, the memorable accident of June 17, 1858, near Port Jervis, on the Erie railway.

As the express train from New York was running at a speed of about thirty miles an hour over a perfectly straight piece of track between Otisville and Port Jervis, shortly after dark on the evening of that day, it encountered a broken rail. The train was made up of a locomotive, two baggage cars and five

passenger cars, all of which except the last passed safely over the fractured rail. The last car was apparently derailed, and drew the car before it off the track. These two cars were then dragged along, swaying fearfully from side to side, for a distance of some four hundred feet, when the couplings at last snapped and they went over the embankment, which was there some thirty feet in height. As they rushed down the slope the last car turned fairly over, resting finally on its roof, while one of its heavy iron trucks broke through and fell upon the passengers beneath, killing and maiming them. The other car, more fortunate, rested at last upon its side on a pile of stones at the foot of the embankment. Six persons were killed and fifty severely injured; all of the former in the last car.

In this case, had the couplings held, the derailed cars would not have gone over the embankment and but slight injuries would have been sustained. Modern improvements have, however, created safeguards sufficient to prevent the recurrence of other accidents under the same conditions as that at Port Jervis. The difficulty lay in the inability to stop a train, though moving at only moderate speed, within a reasonable time. The wretched inefficiency of the old hand-brake in a sudden emergency received one more illustration. The train seems to have run nearly half a mile after the accident took place before it could be stopped, although the engineer had instant notice of it and reversed his locomotive.

The couplings did not snap until a distance had been traversed in which the modern train-brake would have reduced the speed to a point at which they would have been subjected to no dangerous strain.

The accident ten years later at Carr's Rock, sixteen miles west of Port Jervis, on the same road, was again very similar to the one just described: and yet in this case the parting of the couplings alone prevented the rear of the train from dragging its head to destruction. Both disasters were occasioned by broken rails; but, while the first occurred on a tangent, the last was at a point where the road skirted the hills, by a sharp curve, upon the outer side of which was a steep declivity of some eighty feet, jagged with rock and bowlders. It befell the night express on the 14th of April, 1876. The train was a long one, consisting of the locomotive, three baggage and express, and seven passenger cars, and it encountered the broken rail while rounding the curve at a high rate of speed. Again all except the last car, passed over the fracture in safety; this was snapped, as it were, off the track and over the embankment. At first it was dragged along, but only for a short distance; the intense strain then broke the coupling between the four rear cars and the head of the train, and, the last of the four being already over the embankment, the others almost instantly toppled over after it and rolled down the ravine. A passenger on this por-

tion of the train, described the car he was in "as going over and over, until the outer roof was torn off, the sides fell out, and the inner roof was crushed in." Twenty-four persons were killed and eighty injured; but in this instance, as in that at Des Jardines, the only occasion for surprise was that there were any survivors.

Accidents arising from the parting of defective couplings have of course not been uncommon, and they constitute one of the greatest dangers incident to heavy gradients; in surmounting inclines freight trains will, it is found, break in two, and their hinder parts come thundering down the grade, as was seen at Abergele. The American passenger trains, in which each car is provided with brakes, are much less liable than the English, the speed of which is regulated by brake-vans, to accidents of this description. Indeed, it may be questioned whether in America any serious disaster has occurred from the fact that a portion of a passenger train on a road operated by steam got beyond control in descending an incline. There have been, however, terrible catastrophes from this cause in England, and that on the Lancashire & Yorkshire road near Helmshere, a station some fourteen miles north of Manchester, deserves a prominent place in the record of railroad accidents.

It occurred in the early hours of the morning of the 4th of September, 1860. There had been a great *fête* at the Bellevue Gardens in Manchester on

the 3d, upon the conclusion of which some twenty-five hundred persons crowded at once upon the return trains. Of these there were, on the Lancashire & Yorkshire road, three; the first consisting of fourteen, the second of thirty-one, and the last of twenty-four carriages: and they were started, with intervals of ten minutes between them, at about eleven o'clock at night. The first train finished its journey in safety: not so the second and the third. The Helmshere station is at the top of a steep incline. This the second train, drawn by two locomotives, surmounted, and then stopped for the delivery of passengers. While these were leaving the carriages, a snap as of fractured iron was heard, and the guards, looking back, saw the whole rear portion of the train, consisting of seventeen carriages and a brake-van, detached from the rest of it and quietly slipping down the incline. The detached portion was moving so slowly that one of the guards succeeded in catching the van and applying the brakes; it was, however, already too late. The velocity was greater than the brake-power could overcome, and the seventeen carriages kept descending more and more rapidly. Meanwhile the third train had reached the foot of the incline and begun to ascend it, when its engineer, on rounding a curve, caught sight of the descending carriages. He immediatly reversed his engine, but before he could bring his train to a stand they were upon him. Fortunately the van-brakes of the detached carriages, though insufficient

to stop them, yet did reduce their speed; the collision nevertheless was terrific. The force of the blow, so far as the advancing train was concerned, expended itself on the locomotive, which was demolished, while the passengers escaped with a fright. Not so those in the descending carriages. With them there was nothing to break the blow, and the two hindmost carriages were crushed to fragments and their passengers scattered over the line. It was shortly after midnight, and the excursionists clambered out of the trains and rushed frantically about, impeding every effort to clear away the *débris* and rescue the injured, whose shrieks and cries were incessant. The bodies of ten persons, one of whom had died of suffocation, were ultimately taken out from the wreck, and twenty-two others sustained fractures of limbs.

At Des Jardines the couplings were too strong; at Port Jervis and at Helmshere they were not strong enough; at Carr's Rock they gave way not a moment too soon. "There are objections to a plenum, and there are objections to a vacuum," as Dr Johnson remarked, "but a plenum or a vacuum it must be." There are no arguments, however, in favor of putting railroad stations or sidings upon an inclined plane, and then not providing what the English call "catch-points" or "scotches" to prevent such disasters as those at Abergele or Helmshere. In these two instances alone the want of them cost over fifty lives. In railroad mechanics

there are after all some principles susceptible of demonstration. That vehicles, as well as water, will run down hill may be classed among them. That these principles should still be ignored is hardly less singular than it is surprising.

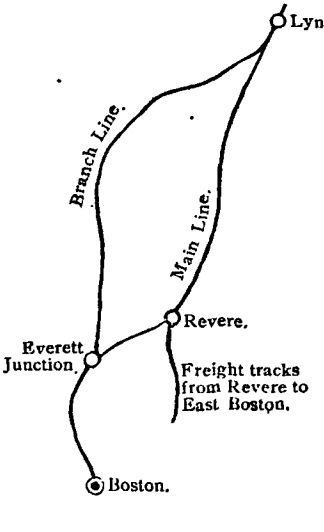
CHAPTER XIV.

THE REVERE CATASTROPHE.

THE terrible disaster which occurred in front of the little station-building at Revere, six miles from Boston on the Eastern railroad of Massachusetts, in August 1871, was, properly speaking, not an accident at all; it was essentially a catastrophe—the legitimate and almost inevitable final outcome of an antiquated and insufficient system. As such it should long remain a subject for prayerful meditation to all those who may at any time be entrusted with the immediate operating of railroads. It was terribly dramatic, but it was also frightfully instructive; and while the lesson was by no means lost, it yet admits of further and advantageous study. For, like most other men whose lives are devoted to a special calling, the managers of railroads are apt to be very much wedded to their own methods, and attention has already more than once been called to the fact that, when any new emergency necessitates a new

appliance, they not infrequently, as Captain Tyler well put it in his report to the Board of Trade for the year 1870, "display more ingenuity in finding objections than in overcoming them."

The Eastern railroad of Massachusetts connects Boston with Portland, in the state of Maine, by a line which is located close along the sea-shore. Between Boston and Lynn, a distance of eleven miles, the main road is in large part built across the salt marshes, but there is a branch which leaves it at Everett, a small station some miles out of Boston, and thence, running deviously through a succession of towns on the higher ground, connects with the main track again at Lynn; thus making what is known in England as a loop-road. At the time of the Revere accident this branch was equipped with but a single track, and was operated wholly by schedule without any reliance on the telegraph; and, indeed, there were not even telegraphic offices at a number of the stations upon it. Revere, the name of the station where the accident took place, was on the main line about five miles from Boston and two miles from Everett, where the



Saugus branch, as the loop-road was called, began. The accompanying diagram shows the relative position of the several points and of the main and branch lines, a thorough appreciation of which is essential to a correct understanding of the disaster.

The travel over the Eastern railroad is of a somewhat exceptional nature, varying in a more than ordinary degree with the different seasons of the year. During the winter months the corporation had, in 1871, to provide for a regular passenger movement of about seventy-five thousand a week, but in the summer what is known as the excursion and pleasure travel not infrequently increased the number to one hundred and ten thousand, and even more. As a natural consequence, during certain weeks of each summer, and more especially towards the close of August, it was no unusual thing for the corporation to find itself taxed beyond its utmost resources. It is emergencies of this description, periodically occurring on every railroad, which always subject to the final test the organization and discipline of companies and the capacity of superintendents. A railroad in quiet times is like a ship in steady weather; almost anybody can manage the one or sail the other. It is the sudden stress which reveals the undeveloped strength or the hidden weakness; and the truly instructive feature in the Revere accident lay in the amount of hidden weakness everywhere which was brought to light under that sudden stress. During the week ending with

that Saturday evening upon which the disaster occurred the rolling stock of the road had been heavily taxed, not only to accommodate the usual tide of summer travel, then at its full flood, but also those attending a military muster and two large camp-meetings upon its line. The number of passengers going over it had accordingly risen from about one hundred and ten thousand, the full summer average, to over one hundred and forty thousand; while instead of the one hundred and fifty-two trains a day provided for in the running schedule, there were no less than one hundred and ninety-two. It had never been the custom with those managing the road to place any reliance upon the telegraph in directing the train movement, and no use whatever appears to have been made of it towards straightening out the numerous hitches inevitable from so sudden an increase in that movement. If an engine broke down, or a train got off the track, there had accordingly throughout that week been nothing done, except patient and general waiting, until things got in motion again; each conductor or station-master had to look out for himself, under the running regulations of the road, and need expect no assistance from headquarters. This, too, in spite of the fact that, including the Saugus branch, no less than ninety-three of the entire one hundred and fifteen miles of road operated by the company were supplied only with a single track. The whole train movement, both of the main line and of the branches, in-

tricate in the extreme as it was, thus depended solely on a schedule arrangement and the watchful intelligence of individual employés. Not unnaturally, therefore, as the week drew to a close the confusion became so great that the trains reached and left the Boston station with an almost total disregard of the schedule; while towards the evening of Saturday the employés of the road at that station directed their efforts almost exclusively to dispatching trains as fast as cars could be procured, thus trying to keep it as clear as possible of the throng of impatient travellers which continually blocked it up. Taken altogether the situation illustrated in a very striking manner that singular reliance of the corporation on the individuality and intelligence of its employés, which in another connection is referred to as one of the most striking characteristics of American railroad management, without a full appreciation of which it is impossible to understand its using or failing to use certain appliances.

According to the regular schedule four trains should have left the Boston station in succession during the hour and a half between 6.30 and eight o'clock P. M.: a Saugus branch train for Lynn at 6.30; a second Saugus branch train at seven; an accommodation train, which ran eighteen miles over the main line, at 7.15; and finally the express train through to Portland, also over the main line, at eight o'clock. The collision at Revere was between these last two trains, the express overtaking and running

into the rear of the accommodation train ; but it was indirectly caused by the delays and irregularity in movement of the two branch trains. It will be noticed that, according to the schedule, both of the branch trains should have preceded the accommodation train; in the prevailing confusion, however, the first of the two branch trains did not leave the station until about seven o'clock, thirty minutes behind its time, and it was followed forty minutes later, not by the second branch train, but by the accommodation train, which in its turn was twenty-five minutes late. Thirteen minutes afterwards the second Saugus branch train, which should have preceded, followed it, being nearly an hour out of time. Then at last came the Portland express, which got away practically on time, at a few minutes after eight o'clock. All of these four trains went out over the same track as far as the junction at Everett, but at that point the first and third of the four were to go off on the branch, while the second and fourth kept on over the main line. Between these last two trains the running schedule of the road allowed an ample time-interval of forty-five minutes, which, however, on this oocasion was reduced, through the delay in starting, to some fifteen or twenty minutes. No causes of further delay, therefore, arising, the simple case was presented of a slow accommodation train being sent out to run eighteen miles in advance of a fast express train, with an interval of twenty minutes between them.

Unfortunately, however, the accommodation train was speedily subjected to another and very serious delay. It has been mentioned that the Saugus branch was a single track road, and the rules of the company were explicit that no outward train was to pass onto the branch at Everett until any inward train then due there should have arrived and passed off it. There was no siding at the junction, upon which an outward branch train could be temporarily placed to wait for the inward train, thus leaving the main track clear; and accordingly, under a strict construction of the rules, any outward branch train while awaiting the arrival at Everett of an inward branch train was to be kept standing on the main track, completely blocking it. The outward branch trains, it subsequently appeared, were often delayed at the junction, but no practical difficulty had arisen from this cause, as the employé in charge of the signals and switches there, exercising his common sense, had been in the custom of moving any delayed train temporarily out of the way onto the branch or the other main track, under protection of a flag, and thus relieving the block. The need of a siding to permit the passage of trains at this point had not been felt, simply because the employé in charge there had used the branch or other main track as a siding. On the day of the accident this employé happened to be sick, and absent from his post. His substitute either had no common sense or did not feel called upon to use it, if its use in-

volved any increase of responsibility. Accordingly, when a block took place, the simple letter of the rule was followed;—and it is almost needless to add that a block did take place on the afternoon of August 26th.

The first of the branch trains, it will be remembered, had left Boston at about seven o'clock, instead of at 6.30, its schedule time. On arriving at Everett this train should have met and passed an inward branch train, which was timed to leave Lynn at six o'clock, but which, owing to some accident to its locomotive, and partaking of the general confusion of the day, on this particular afternoon did not leave the Lynn station until 7.30 o'clock, or one hour and a half after its schedule time, and one half-hour after the other train had left Boston. Accordingly, when the Boston train reached the junction its conductor found himself confronted by the rule forbidding him to enter upon the branch until the Lynn train then due should have passed off it, and so he quietly waited on the outward track of the main line, blocking it completely to traffic. He had not waited long before a special locomotive, on its way from Boston to Salem, came up and stopped behind him. This was presently followed by the accommodation train. Then the next branch train came along, and finally the Portland express. At such a time, and at that period of railroad development, there was something ludicrous about the spectacle. Here was a road utterly unable to accommo-

date its passengers with cars, while a succession of trains were standing idle for hours, because a locomotive had broken down ten miles off. The telegraph was there, but the company was not in the custom of putting any reliance upon it. A simple message to the branch trains to meet and pass at any point other than that fixed in the schedule would have solved the whole difficulty; but, no!—there were the rules, and all the rolling stock of the road might gather at Everett in solemn procession, but, until the locomotive at Lynn could be repaired, the law of the Medes and Persians was plain; and in this case it read that the telegraph was a new-fangled and unreliable auxiliary. And so the lengthening procession stood there long enough for the train which caused it to have gone to its destination and come back dragging the disabled locomotive from Lynn behind it to again take its place in the block.

At last, at about ten minutes after eight o'clock, the long-expected Lynn train made its appearance, and the first of the branch trains from Boston immediately went off the main line. The road was now clear for the accommodation train, which had been standing some twelve or fifteen minutes in the block, but which from the moment of again starting was running on the schedule time of the Portland express. This its conductor did not know. Every minute was vital, and yet he never thought to look at his watch. He had a vague impression that he

had been delayed some six or eight minutes, when in reality he had been delayed fifteen; and, though he was running wholly out of his schedule time, he took not a single precaution, so persuaded was he that every one knew where he was.

The confusion among those in charge of the various engines and trains was, indeed, general and complete. As the Portland express was about to leave the Boston station, the superintendent of the road, knowing by the non-arrival of the branch train from Lynn that there must be a block at the Everett junction, had directed the depot-master to caution the engineer to look out for the trains ahead of him. The order, a merely verbal one, was delivered after the train had started, the depot-master walking along by the side of the slowly-moving locomotive, and was either incorrectly transmitted or not fully understood; the engine-driver supposed it to apply to the branch train which had started just before him, out of both its schedule time and schedule place. Presently, at the junction, he was stopped by the signal man of this train. The course of reasoning he would then have had to pass through to divine the true situation of affairs and to guide himself safely under the schedule in the light of the running rules was complicated indeed, and somewhat as follows: "The branch train," he should have argued to himself, "is stopped, and it is stopped because the train which should have left Lynn at six o'clock has not yet arrived; but, under the

rules, that train should pass off the branch before the 6.30 train could pass onto it; if, therefore, the 'wild' train before me is delayed not only the 6.30 but all intermediate trains must likewise be delayed, and the accommodation train went out this afternoon after the 6.30 train, so it, too, must be in the block ahead of me; unless, indeed, as is usually the case, the signal-master has got it out of the block under the protection of a flag." This line of reasoning was, perhaps, too intricate; at any rate, the engine-driver did not follow it out, but, when he saw the tail-lights immediately before him disappear on the branch, he concluded that the main line was now clear, and dismissed the depot-master's caution from his mind. Meanwhile, as the engine-driver of this train was fully persuaded that the only other train in his front had gone off on the branch, the conductor of the accommodation-train was equally persuaded that the head-light immediately behind him in the block at the junction had been that of the Portland express which consequently should be aware of his position. Both were wrong.

Thus when they left Everett the express was fairly chasing the accommodation train, and overtaking it with terrible rapidity. Even then no collision ought to have been possible. Unfortunately, however, the road had no system, even the crudest, of interval signals; and the utter irregularity prevailing in the train movement seemed to have demoralized the employés along the line, who, though they noticed

the extreme proximity of the two trains to each other as they passed various points, all sluggishly took it for granted that those in charge of them were fully aware of their relative positions and knew what they were about. Thus, as the two trains approached the Revere station, they were so close together as to be on the same piece of straight track at the same time, and a passenger standing at the rear end of the accommodation train distinctly saw the head-light of the express locomotive. The night, however, was not a clear one, for an east wind had prevailed all day, driving a mist in from the sea which lay in banks over the marshes, lifting at times so that distant objects were quite visible, and then obscuring them in its heavy folds. Consequently it did not at all follow, because the powerful reflecting head-light of the locomotive was visible from the accommodation train, that the dim tail-lights of the latter were also visible to those on the locomotive. Here was another mischance. The tail-lights in use by the company were ordinary red lanterns without reflecting power.

The station house at Revere stood at the end of a tangent, the track curving directly before it. In any ordinary weather the tail-lights of a train standing at this station would have been visible for a very considerable distance down the track in the direction of Boston, and even on the night of the accident they were probably visible for a sufficient dis-

tance in which to stop any train approaching at a reasonable rate of speed. Unfortunately the engineer of the Portland express did not at once see them, his attention being wholly absorbed in looking for other signals. Certain freight train tracks to points on the shore diverged from the main line at Revere, and the engine-drivers of all trains approaching that place were notified by signals at a masthead close to the station whether the switches were set for the main line or for these freight tracks. A red lantern at the masthead indicated that the main line was closed; in the absence of any signal it was open. In looking for this signal as he approached Revere the engine-driver of the Portland express was simply attending closely to his business, for, had the red light been at the masthead, his train must at once have been stopped. Unfortunately, however, while peering through the mist at the masthead he overlooked what was directly before him, until, when at last he brought his eyes down to the level, to use his own words at the subsequent inquest, "the tail lights of the accommodation train seemed to spring right up in his face."

When those in charge of the two trains at almost the same moment became aware of the danger, there was yet an interval of some eight hundred feet between them. The express train was, however, moving at a speed of some twenty-five or thirty miles an hour, and was equipped only with the old-fashioned hand-brake. In response to the sharply given signal

from the whistle these were rapidly set, but the rails were damp and slippery, so that the wheels failed to catch upon them, and, when everything was done which could be done, the eight hundred feet of interval sufficed only to reduce the speed of the colliding locomotive to about ten miles an hour.

In the rear car of the accommodation train there were at the moment of the accident some sixty-five or seventy human beings, seated and standing. They were of both sexes and of all ages; for it was a Saturday evening in August, and many persons had, through the confusion of the trains, been long delayed in their return from the city to their homes at the sea-side. The first intimation the passengers had of the danger impending over them was from the sudden and lurid illumination of the car by the glare from the head-light of the approaching locomotive. One of them who survived the disaster, though grievously injured, described how he was carelessly watching a young man standing in the aisle, laughing and gayly chatting with four young girls, who were seated, when he saw him turn and instantly his face, in the sudden blaze of the head-light, assumed a look of frozen horror which was the single thing in the accident indelibly impressed on the survivor's memory; that look haunted him. The car was crowded to its full capacity, and the colliding locomotive struck it with such force as to bury itself two-thirds of its length in it. At the instant of the crash a

panic had seized upon the passengers, and a sort of rush had taken place to the forward end of the car, into which furniture, fixtures and human beings were crushed in a shapeless, indistinguishable mass. Meanwhile the blow had swept away the smoke-stack of the locomotive, and its forward truck had been forced back in some unaccountable way until it rested between its driving wheels and the tender, leaving the entire boiler inside of the passenger car and supported on its rear truck. The valves had been so broken as to admit of the free escape of the scalding steam, while the coals from the fire-box were scattered among the *débris*, and coming in contact with the fluid from the broken car lamps kindled the whole into a rapid blaze. Neither was the fire confined to the last car of the train. It has been mentioned that in the block at Everett a locomotive returning to Salem had found itself stopped just in advance of the accommodation train. At the suggestion of the engine-driver of that train this locomotive had there coupled on to it, and consequently made a part of it at Revere. When the collision took place, therefore, the four cars of which the accommodation train was made up were crushed between the weight of the entire colliding train on one side and that of two locomotives on the other. That they were not wholly demolished was due simply to the fact that the last car yielded to the blow, and permitted the locomotive of the express train fairly to imbed itself in it. As it was,

the remaining cars were jammed and shattered, and, though the passengers in them escaped, the oil from the broken lamps ignited, and before the flames could be extinguished the cars were entirely destroyed.

This accident resulted in the death of twenty-nine persons, and in more or less severe injuries to fifty-seven others. No person, not in the last car of the accommodation train was killed, and one only was seriously injured. Of those in the last car more than half lost their lives; many instantly by crushing, others by inhaling the scalding steam which poured forth from the locomotive boiler into the wreck, and which, where it did not kill, inflicted frightful injuries. Indeed, for the severity of injuries and for the protractedness of agony involved in it, this accident has rarely, if ever, been exceeded. Crushing, scalding and burning did their work together.

It may with perfect truth be said that the disaster at Revere marked an epoch in the history of railroad development in New England. At the moment it called forth the deepest expression of horror and indignation, which, as usual in such cases, was more noticeable for its force than for its wisdom. An utter absence of all spirit of justice is, indeed, a usual characteristic of the more immediate utterances, both from the press and on the platform, upon occasions of this character. Writers and orators seem always to forget that, next to the

immediate sufferers and their families, the unfortunate officials concerned are the greatest losers by railroad accidents. For them, not only reputation but bread is involved. A railroad employé implicated in the occurrence of an accident lives under a stigma. And yet, from the tenor of public comment it might fairly be supposed that these officials are in the custom of plotting to bring disasters about, and take a fiendish delight in them. Nowhere was this ever illustrated more perfectly than in Massachusetts during the last days of August and the early days of September, 1871. Grave men—men who ought to have known better—indulged in language which would have been simply ludicrous save for the horror of the event which occasioned but could not justify it. A public meeting, for instance, was held at the town of Swampscott on the evening of the Monday succeeding the catastrophe. The gentleman who presided over it very discreetly, in his preliminary remarks, urged those who proposed to join in the discussion to control their feelings. Hardly had he ceased speaking, however, when Mr. Wendell Phillips was noticed among the audience, and immediately called to the platform. His remarks were a most singular commentary on the chairman's injunction to calmness. He began by announcing that the first requisite to the formation of a healthy public opinion in regard to railroad accidents, as other things, was absolute frankness of speech, and

he then proceeded as follows:—"So I begin by saying that to my mind this terrible disaster, which has made the last thirty-six hours so sad to us all, is a deliberate murder. I think we should try to get rid in the public mind of any real distinction between the individual who, in a moment of passion or in a moment of heedlessness, takes the life of one fellow-man, and the corporation that in a moment of greed, of little trouble, of little expense, of little care, of little diligence, takes lives by wholesale. I think the first requisite of the public mind is to say that there is no accident in the case, properly speaking. It is a murder; the guilt of murder rests somewhere."

Mr. Phillip's definition of the crime of "deliberate murder" would apparently somewhat unsettle the criminal law as at present understood, but he was not at all alone in this bathos of extravagance. Prominent gentlemen seemed to vie with each other in their display of ignorance. Mr. B. F. Butler, for instance, suggested his view of the disaster and the measure best calculated to prevent a repetition of it; which last was certainly original, inasmuch as he urged the immediate raising of the pay of all enginemen until a sufficiently high order of ability and education should be brought into the occupation to render impossible the recurrence of an accident which was primarily caused by the negligence, not of an engineer, but of a conductor. Another gentleman described with much feeling his observations during

a recent tour in Europe, and declared that such a catastrophe as that at Revere would have been impossible there. As a matter of fact the official reports not only showed that the accident was one of a class of most frequent occurrence, but also that sixty-one cases of it had occurred in Great Britain alone during the very year the gentleman in question was journeying in Europe, and had occasioned over six hundred cases of death or personal injury. Perhaps, in order to illustrate how very reckless in statement a responsible gentleman talking under excitement may become, it is worth while to quote in his own language Captain Tyler's brief description of one of those sixty-one accidents which "could not possibly," but yet did, occur. As miscellaneous reading it is amusing.

"As four London & North-Western excursion trains on September 2, 1870, were returning from a volunteer review at Penrith, the fourth came into collision at Penruddock with the third of those trains. An hundred and ten passengers and three servants of the company were injured. These trains were partly in charge of acting guards, some of whom were entirely inexperienced, as well in the line as in their duties; and of engine-drivers and firemen, of whom one, at all events, was very much the worse for liquor. The side-lamps on the hind van of the third train were obscured by a horse-box, which was wider than the van. There were no special means of protection to meet the exceptional contingency of three such trains all stopping on their way from the eastward, to cross two others from the westward, at this station. And the regulations for telegraphing the trains were altogether neglected."

CHAPTER XV.

REAR END COLLISIONS.

THE annals of railroad accidents are full of cases of "rear-end collision," as it is termed.* Their frequency may almost be accepted as a very accurate gauge of the pressure of traffic on any given system of lines, and because of them the companies are continually compelled to adopt new and more intricate systems of operation. At first, on almost all roads, trains follow each other at such great intervals that no precaution at all, other than flags and lanterns, are found necessary. Then comes a succeeding period when an interval of time between following trains is provided for, through a system of signals which at given points indicate danger during a certain num-

* In the nine years 1870–8, besides those which occurred and were not deemed of sufficient importance to demand special inquiry, 86 cases of accidents of this description were investigated by the inspecting officers of the English Board of Trade and reported upon in detail. In America, 732 cases were reported as occurring during the six years 1874–8, and 138 cases in 1878 alone.

ber of minutes after the passage of every train. Then, presently, the alarming frequency of rear collisions demonstrates the inadequacy of this system, and a new one has to be devised, which, through the aid of electricity, secures between the trains an interval of space as well as of time. This last is known as the "block-system," of which so much has of late years been heard.

The block-system is so important a feature in the modern operation of railroads, and in its present stage of development it illustrates so strikingly the difference between the European and the American methods, that more particular reference will have presently to be made to it.* For the present it is enough to say that rear-end collisions occur notwithstanding all the precautions implied in a thoroughly perfected "block-system." There was such a case on the Metropolitan road, in the very heart of London, on the 29th of August, 1873. It happened in a tunnel. A train was stalled there, and an unfortunate signal officer in a moment of flurry gave "line clear" and sent another train directly into it.

A much more impressive disaster, both in its dramatic features and as illustrating the inadequacy of every precaution depending on human agency to avert accident under certain conditions, was afforded in the case of a collision which occurred on the London & Brighton Railway on August 25, 1861; ten years almost to a day before that at Revere.

* Chapter XVII.

Like the Eastern railroad, the London & Brighton enjoyed an enormous passenger traffic, which became peculiarly heavy during the vacation season towards the close of August; and it was to the presence of the excursion trains made necessary to accomodate this traffic that the catastrophes were in both cases due. In the case of the London & Brighton road it occurred on a Sunday. An excursion train from Portsmouth on that day was to leave Brighton at five minutes after eight A. M., and was to be followed by a regular Sunday excursion train at 8.15 or ten minutes later, and that again, after the lapse of a quarter of an hour, by a regular parliamentary train at 8.30. These trains were certainly timed to run sufficiently near to each other; but, owing to existing pressure of traffic on the line, they started almost simultaneously. The Portsmouth excursion, which consisted of sixteen carriages, was much behind its time, and did not leave the Brighton station until 8.28; when, after a lapse of three minutes, it was followed by the regular excursion train at 8.31, and that again by the parliamentary train at 8.35. Three passenger trains had thus left the station on one track in seven minutes! The London and Brighton Railway traverses the chalky downs, for which that portion of England is noted, through numerous tunnels, the first of which after leaving Brighton is known as the Patcham Tunnel, about five hundred yards in length, while two and a half miles farther on is the Croydon Tun-

nel, rather more than a mile and a quarter in length.

The line between these tunnels was so crooked and obscured that the managers had adopted extraordinary precautions against accident. At each end of the Croydon Tunnel a signal-man was stationed, with a telegraphic apparatus, a clock and a telegraph bell in his station. The rule was absolute that when any train entered the tunnel the signal-man at the point of entry was to telegraph "train in," and no other train could follow until the return signal of "train out" came from the other side. In face of such a regulation it was difficult to see how any collision in the tunnel was possible. When the Portsmouth excursion train arrived, it at once entered the tunnel and the fact was properly signaled to the opposite outlet. Before the return signal that this train was out was received, the regular excursion train came in sight. It should have been stopped by a self-acting signal which was placed about a quarter of a mile from the mouth of the tunnel, and which each passing locomotive set at "danger," where it remained until shifted to "safety," by the signal-man, on receipt of the message, "train out.' Through some unexplained cause, the Portsmouth excursion train had failed to act on this signal, which consequently still indicated safety when the Brighton excursion train came up. Accordingly the engine-driver at once passed it, and went on to the tunnel. As he did so, the signal-man, perceiving some mistake and knowing that he had not yet got his re-

turn signal that the preceding train was out, tried to stop him by waving his red flag. It was too late, however, and the train passed in. A moment later the parliamentary train also came in sight, and stopped at the signal of danger. Now ensued a most singular misapprehension between the signal-men, resulting in a terrible disaster. The second train had run into the tunnel and was supposed by the signal-man to be on its way to the other end of it, when he received the return message that the first train was out. To this he instantly responded by again telegraphing "train in," referring now to the second train. This dispatch the signal-man at the opposite end conceived to be a repetition of the message referring to the first train, and he accordingly again replied that the train was out. This reply, however, the other operator mistook as referring to the second train, and accordingly he signaled "safety," and the third train at once got under way and passed into the tunnel. Unfortunately the engineer of the second train had seen the red flag waved by the signal-man, and, in obedience to it, stopped his locomotive as soon as possible in the tunnel and began to back out of it. In doing so, he drove his train into the locomotive of the third train advancing into it. The tunnel was twenty-four feet in height. The engine of the parliamentary train struck the rear carriage of the excursion train and mounted upon its fragments, and then on those of the carriage in front of it, until its smoke-stack came

in contact with the roof of the tunnel. It rested finally in a nearly upright position. The collision had taken place so far within the tunnel as to be beyond the reach of daylight, and the wreck of the trains had quite blocked up the arch, while the steam and smoke from the engines poured forth with loud sound and in heavy volumes, filling the empty space with stifling and scalding vapors. When at last assistance came and the trains could be separated, twenty-three corpses were taken from the ruins, while one hundred and seventy-six other persons had sustained more or less severe injuries.

A not less extraordinary accident of the same description, unaccompanied, however, by an equal loss of life, occured on the Great Northern Railway upon the 10th of June, 1866. In this case the tube of a locomotive of a freight train burst at about the centre of the Welwyn Tunnel, some five miles north of Hatfield, bringing the train to a stand-still. The guard in charge of the rear of the train failed from some cause to go back and give the signal for an obstruction, and speedily another freight train from the Midland road entered and dashed into the rear of the train already there. Apparently those in charge of these two trains were in such consternation that they did not think to provide against a further disaster; at any rate, before measures to that end had been taken, an additional freight train, this time belonging to the Great Northern road, came up and plowed into the ruins which already

blocked the tunnel. One of the trains had contained wagons laden with casks of oil, which speedily became ignited from contact with the coals scattered from the fire-boxes, and there then ensued one of the most extraordinary spectacles ever witnessed on a railroad. The tunnel was filled to the summit of its arch and completely blocked with the wrecked locomotives and wagons. These had ignited, and the whole cavity, more than a half a mile in length, was converted into one huge furnace, belching forth smoke and flame with a loud roaring sound through its several air shafts. So fierce was the fire that no attempt was made to subdue it, and eighteen hours elapsed before any steps could be taken towards clearing the track. Strange to say, in this disaster the lives of but two persons were lost.

Rear-end collisions have been less frequent in this country than in England, for the simple reason that the volume of traffic has pressed less heavily on the capacity of the lines. Yet here, also, they have been by no means unknown. In 1865 two occurred, both of which were accompanied with a considerable loss of life; though, coming as they did during the exciting scenes which marked the close of the war of the Rebellion, they attracted much less public notice than they otherwise would. The first of these took place in New Jersey on the 7th of March, 1865, just three days after the second inauguration of President Lincoln. As the express train from Washington to New York over the Camden &. Am-

boy road was passing through Bristol, about thirty miles from Philadelphia, at half-past-two o'clock in the morning, it dashed into the rear of the twelve o'clock "owl train," from Kensington to New York, which had been delayed by meeting an oil train on the track before it. The case appears to have been one of very culpable negligence, for, though the owl train was some two hours late, those in charge of it seem to have been so deeply engrossed in what was going on before them that they wholly neglected to guard their rear. The express train accordingly, approaching around a curve, plunged at a high rate of speed into the last car, shattering it to pieces; the engine is even said to have passed completely through that car and to have imbedded itself in the one before it. It so happened that most of the sufferers by this accident, numbering about fifty, were soldiers on their way home from the army upon furlough.

The second of the two disasters referred to, occurred on the 16th of August, 1865, upon the Housatonic road of Connecticut. A new engine was out upon an experimental trip, and in rounding a curve it ran into the rear of a passenger train, which, having encountered a disabled freight train, had coupled on to it and was then backing down with it to a siding in order to get by. In this case the impetus was so great that the colliding locomotive utterly destroyed the rear car of the passenger train and penetrated some distance into

the car preceding it, where its boiler burst. Fortunately the train was by no means full of passengers; but, even as it was, eleven persons were killed and some seventeen badly injured.

CHAPTER XVI.

NOVEL APPLIANCES.

THE great peculiarity of the Revere accident, and that which gave a permanent interest to it, lay in the revelation it afforded of the degree in which a system had outgrown its appliances. At every point a deficiency was apparent. The railroads of New England had long been living on their early reputation, and now, when a sudden test was applied, it was found that they were years behind the time. In August, 1871, the Eastern railroad was run as if it were a line of stage-coaches in the days before the telegraph. Not in one point alone, but in everything, it broke down under the test. The disaster was due not to any single cause but to a combination of causes implicating not only the machinery and appliances in use by the company, but its discipline and efficiency from the highest official down to the meanest subordinate. In the first place the capacity of the road was taxed to the utmost; it was

vital, almost, that every wheel should be kept in motion. Yet, under that very exigency, the wheels stopped almost as a matter of necessity. How could it be otherwise?—Here was a crowded line, more than half of which was equipped with but a single track, in operating which no reliance was placed upon the telegraph. With trains running out of their schedule time and out of their schedule place, engineers and conductors were left to grope their way along as best they could in the light of rules, the essence of which was that when in doubt they were to stand stock still. Then, in the absence of the telegraph, a block occurred almost at the mouth of the terminal station; and there the trains stood for hours in stupid obedience to a stupid rule, because the one man who, with a simple regard to the dictates of common sense, was habitually accustomed to violate it happened to be sick. Trains commonly left a station out of time and out of place; and the engineer of an express train was sent out to run a gauntlet the whole length of the road with a simple verbal injunction to look out for some one before him. Then, at last, when this express train through all this chaos got to chasing an accommodation train, much as a hound might course a hare, there was not a pretence of a signal to indicate the time which had elapsed between the passage of the two, and employés, lanterns in hand, gaped on in bewilderment at the awful race, concluding that they could not at any rate do anything

to help matters, but on the whole they were inclined to think that those most immediately concerned must know what they were about. Finally, even when the disaster was imminent, when deficiency in organization and discipline had done its worst, its consequences might yet have been averted through the use of better appliances; had the one train been equipped with the Westinghouse brake, already largely in use in other sections of the country, it might and would have been stopped; or had the other train been provided with reflecting tail-lights in place of the dim hand-lanterns which glimmered on its rear platform, it could hardly have failed to make its proximity known. Any one of a dozen things, every one of which should have been but was not, ought to have averted the disaster. Obviously its immediate cause was not far to seek. It lay in the carelessness of a conductor who failed to consult his watch, and never knew until the crash came that his train was leisurely moving along on the time of another. Nevertheless, what can be said in extenuation of a system under which, at this late day, a railroad is operated on the principle that each employé under all circumstances can and will take care of himself and of those whose lives and limbs are entrusted to his care?

There is, however, another and far more attractive side to the picture. The lives sacrificed at Revere were not lost in vain. Seven complete railroad years passed by between that and the Wollas-

ton Heights accident of 1878. During that time not less than two hundred and thirty millions of persons were carried by rail within the limits of Massachusetts. Of this vast number, while only 50, or about one in each four and a half millions, sustained any injury from causes beyond their own power to control, the killed were just two. This certainly was a record with which no community could well find fault; and it was due more than anything else to the great disaster of August 26, 1871. More than once, and on more than one road, accidents occurred which, but for the improved appliances introduced in consequence of the experience at Revere, could hardly have failed of fatal results. Not that these appliances were in all cases very cheerfully or very eagerly accepted. Neither the Miller platform nor the Westinghouse brake won its way into general use unchallenged. Indeed, the earnestness and even the indignation with which presidents and superintendents then protested that their car construction was better and stronger than Miller's; that their antiquated hand-brakes were the most improved brakes,—better, much better, than the Westinghouse; that their crude old semaphores and targets afforded a protection to trains which no block-system would ever equal,—all this certainly was comical enough, even in the very shadow of the great tragedy. Men of a certain type always have protested and will always continue to protest that they have nothing to learn;

yet, under the heavy burden of responsibility, learn they still do. They dare not but learn. On this point the figures of the Massachusetts annual returns between the year 1871 and the year 1878 speak volumes. At the time of the Revere disaster, with one single honorable exception,—that of the Boston & Providence road,—both the atmospheric train-brake and the Miller platform, the two greatest modern improvements in American car construction, were practically unrecognized on the railroads of Massachusetts. Even a year later, but 93 locomotives and 415 cars had been equipped even with the train-brake. In September, 1873, the number had, however, risen to 194 locomotives and 709 cars; and another twelve months carried these numbers up to 313 locomotives and 997 cars. Finally in 1877 the state commissioners in their report for that year spoke of the train-brake as having been then generally adopted, and at the same time called attention to the very noticeable fact "that the only railroad accident resulting in the death of a passenger from causes beyond his control within the state during a period of two years and eight months, was caused by the failure of a company to adopt this improvement on all its passenger rolling-stock." The adoption of Miller's method of car construction had meanwhile been hardly less rapid. Almost unknown at the time of the Revere catastrophe in September, 1871, in October, 1873, when returns on the subject were first called for by the state com-

missioners, eleven companies had already adopted it on 778 cars out of a total number of 1548 reported. In 1878 it had been adopted by twenty-two companies, and applied to 1685 cars out of a total of 1792. In other words it had been brought into general use.

CHAPTER XVII.

THE AUTOMATIC ELECTRIC BLOCK SYSTEM.

A REALIZING sense of the necessity of ultimately adopting some system of protection against the danger of rear-end collisions was, above all else, brought directly home to American railroad managers through the Revere disaster. In discussing and comparing the appliances used in the practical operation of railroads in different countries, there is one element, however, which can never be left out of the account. The intelligence, quickness of perception and capacity for taking care of themselves —that combination of qualities which, taken together, constitute individuality and adaptability to circumstance—vary greatly among the railroad employés of different countries. The American locomotive engineer, as he is called, is especially gifted in this way. He can be relied on to take care of himself and his train under circumstances which in other countries would be thought to insure disas-

ter. Volumes on this point were included in the fact that though at the time of the Revere disaster many of the American lines, especially in Massachusetts, were crowded with the trains of a mixed traffic, the necessity of making any provision against rear-end collisions, further than by directing those in immediate charge of the trains to keep a sharp look out and to obey their printed orders, seemed hardly to have occurred to any one. The English block system was now and then referred to in a vague, general way; but it was very questionable whether one in ten of those referring to it knew anything about it or had ever seen it in operation, much less investigated it. A characteristic illustration of this was afforded in the course of those official investigations which followed the Revere disaster, and have already more than once been alluded to. Prior to that disaster the railroads of Massachusetts had, as a rule, enjoyed a rather exceptional freedom from accidents, and there was every reason to suppose that their regulations were as exact and their system as good as those in use in other parts of the country. Yet it then appeared that in the rules of very few of the Massachusetts roads had any provision, even of the simplest character, been made as to the effect of telegraphic orders, or the course to be pursued by employés in charge of trains on their receipt. The appliances for securing intervals between following trains were marked by a quaint simplicity. They were, indeed,

"singularly primitive," as the railroad commissioners on a subsequent occasion described them, when it appeared that on one of the principal roads of the state the interval between two closely following trains was signalled to the engineer of the second train by a station-master's holding up to him as he passed a number of fingers corresponding to the number of minutes since the first train had gone by. For the rest the examination revealed, as the nearest approach to a block system, a queer collection of dials, sand-glasses, green flags, colored lanterns and hand-targets. The climax in the course of that investigation was, however, reached when some reference, involving a description of it, was made to the English block. This was met by a protest on the part of one veteran superintendent, who announced that it might work well under certain circumstances, but for himself he could not be responsible for the operation of a road running the number of trains he had charge of in reliance on any such system. The subject, in fact, was one of which he knew absolutely nothing;—not even that, through the block system and through it alone, fourteen trains were habitually and safely moved under circumstances where he moved one. This occurred in 1871, and though eight years have since elapsed information in regard to the block system is not yet very widely disseminated inside of railroad circles, much less outside of them. It is none the less a necessity of the

future. It has got to be understood, and, in some form, it has got to be adopted; for even in America there are limits to the reliance which, when the lives and limbs of many are at stake, can be placed on the "sharp look out" of any class of men, no matter how intelligent they may be.

The block system is of English origin, and it scarcely needs to be said that it was adopted by the railroad corporations of that country only when they were driven to it by the exigencies of their traffic. But for that system, indeed, the most costly portion of the tracks of the English roads must of necessity have been duplicated years ago, as their traffic had fairly outgrown those appliances of safety which have even to this time been found sufficient in America. There were points, for instance, where two hundred and seventy regular trains of one line alone passed daily. On the London & North-Western there are more than sixty through down trains, taking no account of local trains, each day passing over the same line of tracks, among which are express trains which stop nowhere, way trains which stop everywhere, express-freight, way-freight, mineral trains and parcel trains. On the Midland road there are nearly twice as many similar trains on each track. On the Metropolitan railway the average interval is three and one-third minutes between trains. In one case points were mentioned where 270 regular trains of one line alone passed a given junction during each twenty-four hours,—where 470 trains

passed a single station, the regular interval between them being but five-eighths of a mile,—where 132 trains entered and left a single station during three hours of each evening every day, being one train in eighty-two seconds. In 1870 there daily reached or left the six stations of the Boston roads some 385 trains; while no less than 650 trains a day were in the same year received and despatched from a single one of the London stations. On one single exceptional occasion 1,111 trains, carrying 145,000 persons, were reported as entering and leaving this station in the space of eighteen hours, being rather more than a train a minute. Indeed it may well be questioned whether the world anywhere else furnishes an illustration so apt and dramatic of the great mechanical achievements of recent times as that to be seen during the busy hours of any week-day from the signal and interlocking galleries which span the tracks as they enter the Charing Cross or Cannon street stations in London. Below and in front of the galleries the trains glide to and fro, coming suddenly into sight from beyond the bridges and as suddenly disappearing,—winding swiftly in and out, and at times four of them running side by side on as many tracks but in both directions,—the whole making up a swiftly shifting maze of complex movement under the influence of which a head unaccustomed to the sight grows actually giddy. Yet it is all done so quietly and smoothly, with such an absence of haste and nervousness on the part of the

stolid operators in charge, that it is not easy to decide which most to wonder at, the almost inconceivable magnitude and despatch of the train-movement or the perfection of the appliances which make it possible. No man concerned in the larger management of railroads, who has not passed a morning in those London galleries, knows what it is to handle a great city's traffic.

Perfect as it is in its way, however, it may well be questioned whether the block system as developed in England is likely to be generally adopted on American railroads. Upon one or two of them, and notably on the New Jersey Central and a division of the Pennsylvania, it has already been in use for a number of years. From an American point of view, however, it is open to a number of objections. That in itself it is very perfect and has been successfully elaborated so as to provide for almost every possible contingency is proved by the results daily accomplished by means of it.* The English lines are made to do an incredible amount of work with comparative few accidents. The block system is, however, none the less a very clumsy and complicated one, necessitating the constant employment of a large number of skilled operators. Here is the great defect in it from the American point of view. In this country labor is scarce and capital costly. The effort is always towards the perfecting of

* An excellent popular description of this system will be found in Barry's *Railway Appliances, Chapter V.*

labor-saving machines. Hitherto the pressure of traffic on the lines has not been greater than could be fairly controlled by simpler appliances, and the expense of the English system is so heavy that its adoption, except partially, would not have been warranted. As Barry says in his treatise on the subject, "one can 'buy gold too dear'; for if every possible known precaution is to be taken, regardless of cost, it may not pay to work a railway at all."

It is tolerably safe, therefore, to predict that the American block system of the future will be essentially different from the present English system. The basis—electricity—will of course be the same; but, while the operator is everywhere in the English block, his place will be supplied to the utmost possible degree by automatic action in the American. It is in this direction that the whole movement since the Revere disaster has been going on, and the advance has been very great. From peculiarities of condition also the American block must be made to cover a multitude of weak points in the operation of roads, and give timely notice of dangers against which the English block provides only to a limited degree, and always through the presence of yet other employés. For instance, as will presently be seen, many more accidents and, in Europe even, far greater loss of life is caused by locomotives coming in contact with vehicles at points where highways cross railroad tracks at a level therewith than by rear-end collisions; meanwhile throughout

America, even in the most crowded suburban neighborhoods, these crossings are the rule, whereas in Europe they are the exception. The English block affords protection against this danger by giving electric notice to gatemen; but gatemen are always supposed. So also as respects the movements of passengers in and about stations in crossing tracks as they come to or leave the trains, or prepare to take their places in them. The rule in Europe is that passenger crossings at local stations are provided over or under the tracks; in America, however, almost nowhere is any provision at all made, but passengers, men, women and children, are left to scramble across tracks as best they can in the face of passing trains. They are expected to take care of themselves, and the success with which they do it is most astonishing. Having been brought up to this self-care all their lives, they do not, as would naturally be supposed, become confused and stumble under the wheels of locomotives; and the statistics seem to show that no more accidents from this cause occur in America than in Europe. Nevertheless some provision is manifestly desirable to notify employés as well as passengers that trains are approaching, especially where way-stations are situated on curves.

Again, it is well known that, next to collisions, the greatest source of danger to railroad trains is due to broken tracks. It is, of course, apparent that tracks may at any time be broken by accident, as by

earth-slides, derailment or the fracture of rails. This danger has to be otherwise provided for; the block has nothing to do with it further than to prevent a train delayed by any such break from being run into by any following train. The broken track which the perfect block should give notice of is that where the break is a necessary incident to the regular operation of the road. It is these breaks which, both in America and elsewhere, are the fruitful source of the great majority of railroad accidents, and draw-bridges and switches, or facing points as they are termed in the English reports, are most prominent among them. Wherever there is a switch, the chances are that in the course of time there will be an accident.

Four matters connected with train movement have now been specified, in regard to which some provision is either necessary or highly desirable: these are rear collisions, tracks broken at draw-bridges or at switches, highway grade crossings, and the notification of agents and passengers at stations. The effort in America, somewhat in advance of that crowded condition of the lines which makes the adoption of something a measure of present necessity, has been directed towards the invention of an automatic system which at one and the same time should cover all the dangers and provide for all the needs which have been referred to, eliminating the risks incident to human forgetfulness, drowsiness and weakness of nerves. Can reliable automatic provision thus be made?—The English

authorities are of opinion that it cannot. They insist that "if automatic arrangements be adopted, however suitable they may be to the duties which they have to perform, they should in all cases be used as additions to, and not as substitutions for, safety-machinery worked by competent signal-men. The signal-man should be bound to exercise his observation, care and judgment, and to act thereon; and the machine, as far as possible, be such that if he attempts to go wrong it shall check him."

It certainly cannot be said that the American electrician has as yet demonstrated the incorrectness of this conclusion, but he has undoubtedly made a good deal of progress in that direction. Of the various automatic blocks which have now been experimented with or brought into practice, the Hall Electric and the Union Safety Signal Company systems have been developed to a very marked degree of perfection. They depend for their working on diametrically opposite principles: the Hall signals being worked by means of an electric circuit caused by the action of wheels moving on the rails, and conveyed through the usual medium of wires; while, under the other system, the wires being wholly dispensed with, a continuous electric circuit is kept up by means of the rails, which are connected for the purpose, and the signals are then acted upon through the breaking of this normal circuit by the movement of locomotives and cars. So far as the signals are concerned, there is

no essential difference between the two systems, except that Hall supplies the necessary motive force by the direct action of electricity, while in the other case dependence is placed upon suspended weights. Of the two the Hall system is the oldest and most thoroughly elaborated, having been compelled to pass through that long and useful tentative process common to all inventions, during which they are regarded as of doubtful utility and are gradually developed through a succession of partial failures. So far as Hall's system is concerned this period may now fairly be regarded as over, for it is in established use on a number of the more crowded roads of the North, and especially of New England, while the imperfections necessarily incident to the development of an appliance at once so delicate and so complicated, have for certain purposes been clearly overcome. Its signal arrangements, for instance, to protect draw-bridges, stations and grade-crossings are wholly distinct from its block system, through which it provides against dangers from collision and broken tracks. So far as draw-bridges are concerned, the protection it affords is perfect. Not only is its interlocking apparatus so designed that the opening of the draw blocks all approach to it, but the signals are also reciprocal; and if through carelessness or automatic derangement any train passes the block, the draw-tender is notified at once of the fact in ample time to stop it.

In the case of a highway crossing at a level, the electric bell under Hall's system is placed at the crossing, giving notice of the approaching train from the moment it is within half a mile until it passes; so that, where this appliance is in use, accidents can happen only through the gross carelessness of those using the highway. When the electric bell is silent there is no train within half a mile and the crossing is safe; it is not safe while the bell is ringing. As it now stands the law usually provides that the prescribed signals, either bell or whistle, shall be given from the locomotive as it approaches the highway, and at a fixed distance from it. The signal, therefore, is given at a distance of several hundred yards, more or less, from the point of danger. The electric system improves on this by placing the signal directly at the point of danger,—the traveller approaches the bell, instead of the bell approaching the traveller. At any point of crossing which is really dangerous,—that is at any crossing where trees or cuttings or buildings mask the railroad from the highway,—this distinction is vital. In the one case notice of the unseen danger must be given and cannot be unobserved; in the other case whether it is really given or not may depend on the condition of the atmosphere or the direction of the wind.

Usually, however, in New England the level crossings of the more crowded thoroughfares, perhaps one in ten of the whole number, are protected

by gates or flag-men. Under similar circumstances in Great Britain there is an electric connection between a bell in the cabin of the gate-keeper and the nearest signal boxes of the block system on each side of the crossing, so that due notice is given of the approach of trains from either direction. In this country it has heretofore been the custom to warn gate-keepers by the locomotive whistle, to the intense annoyance of all persons dwelling near the crossing, or to make them depend for notice on their own eyes. Under the Hall system, however, the gate-keeper is automatically signalled to be on the look out, if he is attending to his duty; or, if he is neglecting it, the electric bell in some degree supplies his place, without releasing the corporation from its liability. In America the heavy fogs of England are almost unknown, and the brilliant head lights, heavy bells and shrill high whistles in use on the locomotives would at night, it might be supposed, give ample notice to the most careless of an approaching train. Continually recurring experience shows, however, that this is not the case. Under these circumstances the electric bell at the crossing becomes not only a matter of justice almost to the employé who is stationed there, but a watchman over him.

This, however, like the other forms of signals which have been referred to, is, in the electric system, a mere adjunct of its chief use, which is the block,—they are all as it were things thrown into

the bargain. As contradistinguished from the English block, which insures only an unoccupied track, the automatic blocks seek to insure an unbroken track as well,—that is not only is each segment into which a road is divided, protected as respects following trains by, in the case of Hall's system, double signals watching over each other, the one at safety, the other at danger,—both having to combine to open the block,—but every switch or facing point, the throwing of which may break the main track, is also protected. The Union Signal Company's system it is claimed goes still further than this and indicates any break in the track, though due to accidental fracture or displacement of rails. Without attempting this the Hall system has one other important feature in common with the English block, and a very important feature, that of enabling station agents in case of sudden emergency to control the train movement within half a mile or more of their stations on either side. Within the given distance they can stop trains either leaving or approaching. The inability to do this has been the cause of some of the most disastrous collisions on record, and notably those at Revere and at Thorpe.

The one essential thing, however, in every perfect block system, whether automatic or worked by operators, is that in case of accident or derangement or doubt, the signal should rest at danger. This the Hall system now fully provides for, and in case even

of the wilful displacement of a switch, an occurrence by no means without precedent in railroad experience, the danger signal could not but be displayed, even though the electric connection had been tampered with. Accidents due to wilfullness, however, can hardly be provided for except by police precautions. Train wrecking is not to be taken into account as a danger incident to the ordinary operation of a railroad. Carelessness or momentary inadvertence, or, most dangerous of all, that recklessness—that unnecessary assumption of risk somewhere or at some time, which is almost inseparable from a long immunity from disaster—these are the great sources of peril most carefully to be guarded against. The complicated and unceasing train movement depends upon many thousand employés, all of whom make mistakes or assume risks sometimes;—and did they not do so they would be either more or less than men. Being, however, neither angels nor machines, but ordinary mortals whose services are bought for money at the average market rate of wages, it would certainly seem no small point gained if an automatic machine could be placed on guard over those whom it is the great effort of railroad discipline to reduce to automatons. Could this result be attained, the unintentional throwing of a lever or the carelessness which leaves it thrown, would simply block the track instead of leaving it broken. An example of this, and at the same time a most forcible illustration of the possible

cost of a small economy in the application of a safeguard, was furnished in the case of the Wollaston disaster. At the time of that disaster, the Old Colony railroad had for several years been partially equipped on the portion of its track near Boston, upon which the accident occurred, with Hall's system. It had worked smoothly and easily, was well understood by the employés, and the company was sufficiently satisfied with it to have even then made arrangements for its extension. Unfortunately, with a too careful eye to the expenditure involved, the line had been but partially equipped; points where little danger was apprehended had not been protected. Among these was the "Foundry switch," so called, near Wollaston. Had this switch been connected with the system and covered by a signal-target, the mere act of throwing it would have automatically blocked the track, and only when it was re-set would the track have been opened. The switch was not connected, the train hands were recklessly careless, and so a trifling economy cost in one unguarded moment some fifty persons life and limb, and the corporation more than $300,000.

One objection to the automatic block is generally based upon the delicacy and complicated character of the machinery on which its action necessarily depends; and this objection is especially urged against those other portions of the Hall system, covering draws and level crossings, which have been particularly described. It is argued that

it is always liable to get out of order from a great multiplicity of causes, some of which are very difficult to guard against, and that it is sure to get out of order during any electric disturbance; but it is during storms that accidents are most likely to occur, and especially is this the case at highway grade-crossings. It is comparatively easy to avoid accidents so long as the skies are clear and the elements quiet; but it is exactly when this is not the case and when it becomes necessary to use every precaution, that electricity as a safeguard fails or runs mad, and, by participating in the general confusion, proves itself worse than nothing. Then it will be found that those in charge of trains and tracks, who have been educated into a reliance upon it under ordinary circumstances, will from force of habit, if nothing else, go on relying upon it, and disaster will surely follow.

This line of reasoning is plausible, but none the less open to one serious objection; it is sustained neither by statistics nor by practical experience. Moreover it is not new, for, slightly varied in phraseology, it has been persistently urged against the introduction of every new railroad appliance, and, indeed, was first and most persistently of all urged against the introduction of railroads themselves. Pretty and ingenious in theory, practically it is not feasible!—for more than half a century this formula has been heard. That the automatic electric signal system is complicated, and in many of its

parts of most delicate construction, is undeniable. So also is the locomotive. In point of fact the whole railroad organization from beginning to end —from machine-shop to train-movement—is at once so vast and complicated, so delicate in that action which goes on with such velocity and power, that it is small cause for wonder that in the beginning all plain, sensible, practical men scouted it as the fanciful creation of visionaries. They were wholly justified in so doing; and to-day any sane man would of course pronounce the combined safety and rapidity of ordinary railroad movement an utter impossibility, did he not see it going on before his eyes. So it is with each new appliance. It is ever suggested that at last the final result has already been reached. It is but a few years, as will presently be seen, since the Westinghouse brake encountered the old "pretty and ingenious" formula. Going yet a step further, and taking the case of electricity itself, the bold conception of operating an entire line of single track road wholly as respects one half of its train movement by telegraph, and without the use of any time table at all, would once have been condemned as mad. Yet to-day half of the vast freight movement of this continent is carried on in absolute reliance on the telegraph. Nevertheless it is still not uncommon to hear among the class of men who rise to the height of their capacity in themselves being automaton superintendents that they do not believe in deviating

from their time tables and printed rules; that, acting under them, the men know or ought to know exactly what to do, and any interference by a train despatcher only relieves them of responsibility, and is more likely to lead to accidents than if they were left alone to grope their own way out.

Another and very similar argument frequently urged against the electric, in common with all other block systems by the large class who prefer to exercise their ingenuity in finding objections rather than in overcoming difficulties, is that they breed dependence and carelessness in employés;—that engine-drivers accustomed to rely on the signals, rely on them implicitly, and get into habits of recklessness which lead inevitably to accidents, for which they then contend the signals, and not they themselves, are responsible. This argument is, indeed, hardly less familiar than the "pretty and ingenious" formula just referred to. It has, however, been met and disposed of by Captain Tyler in his annual reports to the Board of Trade in a way which can hardly be improved upon:—

> It is a favorite argument with those who oppose the introduction of some of these improvements, or who make excuses for the want of them, that their servants are apt to become more careless from the use of them, in consequence of the extra security which they are believed to afford; and it is desirable to consider seriously how much of truth there is in this assertion. * * * Allowing to the utmost for these tendencies to confide

too much in additional means of safety, the risk is proved by experience to be very much greater without them than with them; and, in fact, the negligence and mistakes of servants are found to occur most frequently, and generally with the most serious results, not when the men are over-confident in their appliances or apparatus, but when, in the absence of them, they are habituated to risk in the conduct of the traffic. In the daily practice of railway working station-masters, porters, signalmen, engine-drivers or guards are frequently placed in difficulties which they have to surmount as best they can. The more they are accustomed to incur risk in order to perform their duties, the less they think of it, and the more difficult it is to enforce discipline and obedience to regulations. The personal risk which is encountered by certain classes of railway servants is coming to be more precisely ascertained. It is very considerable; and it is difficult to prevent men who are in constant danger themselves from doing things which may be a source of danger to others, or to compel them to obey regulations for which they do not see altogether the necessity, and which impede them in their work. This difficulty increases with the want of necessary means and appliances; and is diminished when, with proper means and appliances, stricter discipline becomes possible, safer modes of working become habitual, and a higher margin of safety is constantly preserved.*

In Great Britain the ingenious theory that superior appliances or greater personal comfort in some indefinable way lead to carelessness in employés was carried to such an extent that only within the last few years has any protection against wind, rain and sunshine been furnished on locomotives for the engine-drivers and stokers. The old stage-coach

* Reports; 1872, page 23, and 1873, page 39.

driver faced the elements, and why should not his successor on the locomotive do the same?—If made too comfortable, he would become careless and go to sleep!—This was the line of argument advanced, and the tortures to which the wretched men were subjected in consequence of it led to their fortifying nature by drink. They had to be regularly inspected and examined before mounting the footboard, to see that they were sober. It took years in Great Britain for intelligent railroad managers to learn that the more protected and comfortable a man is the better he will attend to his duty. And even when the old argument, refuted by long experience, was at last abandoned as respected the locomotive cab, it, with perfect freshness and confidence in its own novelty and force, promptly showed its brutal visage in opposition to the next new safeguard.

For the reasons which Captain Tyler has so forcibly put in the extracts which have just been quoted, the argument against the block system from the increased carelessness of employés, supposed to be induced by it, is entitled to no weight. Neither is the argument from the delicacy and complication of the automatic, electric signal system entitled to any more, when urged against that. Not only has it been too often refuted under similar conditions by practical results, but in this case it is based on certain assumptions of fact which are wholly opposed to experience. The record does not show that there is any

peculiar liability to railroad accidents during periods of storm; perhaps because those in charge of train movements or persons crossing tracks are under such circumstances more especially on the look out for danger. On the contrary the full average of accidents of the worst description appear to have occurred under the most ordinary conditions of weather, and usually in the most unanticipated way. This is peculiarly true of accidents at highway grade crossings. These commonly occur when the conditions are such as to cause the highway travelers to suppose that, if any danger existed, they could not but be aware of it. In the next place, the question in regard to automatic electric signals is exactly what it was in regard to the Westinghouse brake, with its air-pump, its valves and connecting tubes;—it is the purely practical question,—Does the thing work?—The burden of proof is properly on the inventor. The presumption is all against him. In the case of the electric signals they have for years been in limited but constant use, and while thus in use they have been undergoing steady improvement. Though now brought to a considerable degree of comparative perfection they are, of course, still in their earlier stage of development. In use, however, they have not been found open to the practical objections urged against them. At first much too complicated and expensive, requiring more machinery than could by any reasonable exertions be kept

in order and more care than they were worth, they have now been simplified until a single battery properly located can do all the necessary work for a road of indefinite length. As a system they are effective and do not lead to accidents; nor are they any more subject than telegraph wires to derangement from atmospheric causes. When any disturbance does take place, until it can be overcome it amounts simply to a general signal for operating the road with extreme caution. But with railroads, as everywhere else in life, it is the normal condition of affairs for which provision must be made, while the dangers incident to exceptional circumstances must be met by exceptional precautions. As long as things are in their normal state, that is, probably, during nineteen days out of twenty, the electric signals have now through several years of constant trial proved themselves a reliable safeguard. It can hardly admit of doubt that in the near future they will be both further perfected and generally adopted.

CHAPTER XVIII.

INTERLOCKING.

IN their management of switches, especially at points of railroad convergence where a heavy traffic is concentrated and the passage of trains or movement of cars and locomotives is unceasing, the English are immeasurably in advance of the Americans; and, indeed, of all other people. In fact, in this respect the American managers have shown themselves slow to learn, and have evinced an indisposition to adopt labor-saving appliances which, considering their usual quickness of discernment in that regard, is at first sight inexplicable. Having always been accustomed to the old and simple methods, just so long as they can through those methods handle their traffic with a bearable degree of inconvenience and expense, they will continue to do so. That their present method is most extravagant, just as extravagant as it would be to rent two houses or to run two steam engines where one, if properly

used, could be made to suffice, admits of demonstration;—but the waste is not on the surface, and the necessity for economy is not imperative. The difference of conditions and the difference in results may be made very obvious by a comparison. Take, for instance, London and Boston—the Cannon street station in the one and the Beach street station in the other. The concentration of traffic at London is so great that it becomes necessary to utilize every foot of ground devoted to railroad purposes to the utmost possible extent. Not only must it be packed with tracks, but those tracks must never be idle. The incessant train movement at Cannon street has already been referred to as probably the most extraordinary and confusing spectacle in the whole wide circle of railroad wonders. The result is that in some way, at this one station and under this single roof, more trains must daily be made to enter and leave than enter and leave, not only the Beach street station, but all the eight railroad stations in Boston combined.*

* "It has been estimated that an average of 50,000 persons were, in 1869, daily brought into Boston and carried from it, on three hundred and eighty-five trains, while the South Eastern railway of London received and despatched in 1870, on an average, six hundred and fifty trains a day, between 6 A.M. and 12 P.M. carrying from 35,000 to 40,000 persons, and this too without the occurrence of a single train accident during the year. On one single exceptional day eleven hundred and eleven trains, carrying 145,000 persons, are said to have entered and left this station in the space of eighteen hours."—*Third Annual Report*, [1872] *of Massachusetts Railroad Commissioners, p.* 141.

The passenger movement over the roads terminating in Boston was probably as heavy on June 17, 1875, as during any twenty-four hours

During eighteen successive hours trains have been made to enter and leave this station at the rate of more than one in each minute. It contains four platforms and seven tracks, the longest of which is 720 feet. As compared with the largest station in Boston (the Boston & Providence), it has the same number of platforms and an aggregate of 1,500 (three-fifths) more feet of track under cover; it daily accommodates about nine times as many trains and four times as many passengers. Of it Barry, in his treatise on Railway Appliances (p. 197), says: "The platform area at this station is probably minimised but, the station accommodates efficiently a very large mixed traffic of long and short journey trains, amounting at times to as many as 400 trains in and 400 trains out in a working day.*"

The American system is, therefore, one of great waste; for, being conducted in the way it is—that is with stations and tracks utilized to but a fractional part of their utmost capacity—it requires a large number of stations and tracks and the services of many employés. Indeed it is safe to say that,

in their history. It was returned at 280,000 persons carried in 641 trains. About twice the passenger movement of the "exceptional day" referred to, carried in something more than half the number of trains, entering and leaving eight stations instead of one.

* The Grand Central Depot on 42d Street in New York City, has nearly twice the amount of track room under cover of the Cannon street station. The daily train movement of the latter would be precisely paralleled in New York, though not equalled in amount, if the 42d street station were at Trinity church, and, in addition to the trains which now enter and leave it, all the city trains of the Elevated road were also provided for there.

judged by the London standard, not more than two of the eight stations in Boston are at this time utilized to above a quarter part of their full working capacity; and the same is probably true of all other American cities. Both employés and the travelling public are accustomed to a slow movement and abundance of room; land is comparatively cheap, and the pressure of concentration has only just begun to make itself felt. Accordingly any person, who cares to pass an hour during the busy time of day in front of an American city station, cannot but be struck, while watching the constant movement, with the primitive way in which it is conducted. Here are a multiplicity of tracks all connected with each other, and cars and locomotives are being passed from one to another from morning to night. A constant shifting of switches is going on, and the little shunting engines never stand still. The switches, however, as a rule, are unprovided with signals, except of the crudest description; they have no connection with each other, and during thirty years no change has been made in the method in which they are worked. When one of them has to be shifted, a man goes to it and shifts it. To facilitate the process, the monitor shunting engines are provided with a foot-board in front and behind, just above the track, upon which the yard hands jump, and are carried about from switch to switch, thus saving the time they would occupy if they had to walk. A simpler arrangement could

not be imagined; anyone could devise it. The only wonder is that even a considerable traffic can be conducted safely in reliance upon it.

Turning from Beach to Cannon street, it is apparent that the train movement which has there to be accommodated would fall into inextricable confusion if it was attempted to manage it in the way which has been described. The number of trains is so great and the movement so rapid and intricate, that not even a regiment of employés stationed here and there at the signals and switches could keep things in motion. From time to time they would block, and then the whole vast machine would be brought to a standstill until order could be re-established. The difficulty is overcome in a very simple way, by means of an equally simple apparatus. The control over the numerous switches and corresponding signals, instead of being divided up among many men stationed at many points, is concentrated in the hands of two men occupying a single gallery, which is elevated across the tracks in front of the station and commanding the approaches to it, much as the pilot-house of an American steamer commands a view of the course before it. From this gallery, by means of what is known as the interlocking system, every switch and signal in the yard below is moved; and to such a point of perfection has the apparatus been carried, that any disaster from the misplacement of a switch or the display of a wrong signal is rendered impossible. Of this Can-

non street apparatus Barry says, "there are here nearly seventy point and signal levers concentrated in one signal house; the number of combinations which would be possible if all the signal and point levers were not interlocked can be expressed only by millions. Of these only 808 combinations are safe, and by the interlocking apparatus these 808 combinations are rendered possible, and all the others impossible."*

It is not proposed to enter at any length into the mechanical details of this appliance, which, however, must be considered as one of the three or four great inventions which have marked epochs in the history of railroad traffic.† As, however, it is but little known in America, and will inevitably within the next few years find here the widest field for its increased use, a slight sketch of its gradual development and of its leading mechanical features may not be out of place. Prior to the year 1846 the switches and signals on the English roads were worked in the same way that they are now commonly worked in this country. As a train drew near to a junction, for instance, the switchman stationed there made the proper track connection and then displayed the signal which indicated what tracks were opened and what closed, and which line had the right of way;

* *Railway Appliances*, p. 113.

† A sufficiently popular description of this apparatus also, illustrated by cuts, will be found in Barry's excellent little treatise on *Railway Appliances*, already referred to, published by Longmans & Co. as one of their series of text-books of science.

and the engine-drivers acted accordingly. As the number of trains increased and the movement at the junctions became more complicated, the danger of the wrong switches being thrown or the wrong signals displayed, increased also. Mistakes from time to time would happen, even when only the most careful and experienced men were employed; and mistakes in these matters led to serious consequences. It, therefore, became the practice, instead of having the switch or signal lever at the point where the switch or signal itself was, as is still almost universally the case in this country, to connect them by rods or wires with their levers, which were concentrated at some convenient point for working, and placed under the control of one man instead of several. So far as it went this change was an improvement, but no provision yet existed against the danger of mistake in throwing switches and displaying signals. The blunder of first making one combination of tracks and then showing the signal for another was less liable to happen after the concentration of the levers under one hand than before, but it still might happen at any time, and certainly would happen at some time. If all danger of accident from human fallibility was ever to be eliminated a far more complicated mechanical apparatus must be devised. In response to this need the system of interlocking was gradually developed, though not until about the year 1856 was it brought to any considerable degree of perfection. The whole

object of this system is to render it impossible for a switchman, whether because he is weary or agitated or actually malicious or only inexperienced, to give contrary signals, or to break his line in one way and to give the signal for its being broken in another way. To bring this about the levers are concentrated in a cabin or gallery, and placed side by side in a frame, their lower ends connecting with the switch-points and signals by means of rods and wires. Beneath this frame are one or more long bars, extending its entire length under it and parallel with it. These are called locking bars; for, being moved to the right or left by the action of the levers they hold these levers in certain designated positions, nor do they permit them to occupy any other. In this way what is termed the interlocking is effected. The apparatus, though complicated, is simplicity itself compared with a clock or a locomotive. The complication, also, such as it is, arises from the fact that each situation is a problem by itself, and as such has to be studied out and provided for separately. This, however, is a difficulty affecting the manufacturer rather than the operator. To the latter the apparatus presents no difficulty which a fairly intelligent mechanic cannot easily master; while for the former the highly complicated nature of the problem may, perhaps, best be inferred from the example given by Mr. Barry, the simplest that can offer, that of an ordinary junction where a double-track branch-road connects with

its double-track main line. There would in this case, be of necessity two switch levers and four signal levers, which would admit of sixty-four possible combinations. "The signal might be arranged in any of sixteen ways, and the points might occupy any of four positions, irrespective of the position of the signals. Of the sixty-four combinations thus possible only thirteen are safe, and the rest are such as might lure an engine-driver into danger."

Originally the locking bar was worked through the direct action of certain locks, as they were called, between which the levers when moved played to and fro. These locks were mere bars or plates of iron, some with inclined sides, and others with sides indented or notched. At one end they were secured on a pivot to a fixed bar opposite to and parallel with the movable locking bar, while their other ends were made fast to the locking bar; whence it necessarily followed that, as certain of the levers were pushed to and fro between them, the action of these levers on the inclined sides of the locks could by a skilful combination be made to throw other levers into the notches and indentations of other locks, thus securing them in certain positions, and making it impossible for them to be in any other positions.

The apparatus which has been described, though a great improvement on anything which had preceded it, was still but a clumsy affair, and naturally

the friction of the levers on the locks was so great that they soon became worn, and when worn they could not be relied upon to move the switch-points with the necessary accuracy. The new appliance of safety had, therefore, as is often the case, introduced a new and very considerable danger of its own. The signals and switches, it was true, could no longer disagree, but the points themselves were sometimes not properly set, or, owing to the great exertion required to work it, the interlocking gear was strained. This difficulty resulted in the next and last improvement, which was a genuine triumph of mechanical ingenuity. To insure the proper length of stroke being made in moving the lever—that is to make it certain in each case that the switch points were brought into exactly the proper position—two notches were provided in the slot, or quadrant, as it is called, in which the lever moved, and, when it was thrown squarely home, and not until then, a spring catch caught in one or other of these notches. This spring was worked by a clasp at the handle of the lever, and the whole was called the spring catch-rod. By a singularly ingenious contrivance, the process of interlocking was transferred from the action of the levers and the keys to these spring catch-rods, which were made to work upon each other, and thus to become the medium through which the whole process is effected. The result of this improvement was that, as the switchman cannot move any lever until the spring-

catch rod is fastened, except for a particular movement, he cannot, do what he will, even begin any other movement than that one, as the levers cannot be started. On the other hand, it may be said that, by means of this improvement, the mere "intention of the signal-man to move any lever, expressed by his grasping the lever and so raising the spring catch-rod, independently of his putting his intention in force, actuates all the necessary locking.* "

* In regard to the interlocking system as then in use in England, Captain Tyler in his report as head of the railway inspecting department of the Board of Trade, used the following language in his report on the accidents during 1870. "When the apparatus is properly constructed and efficiently maintained, the signalman cannot make a mistake in the working of his points and signals which shall lead to accident or collision, except only by first lowering his signal and switching his train forward, then putting up his signal again as it approaches, and altering the points as the driver comes up to, or while he is passing over them. Such a mistake was actually made in one of the cases above quoted. It is, of course, impossible to provide completely for cases of this description; but the locking apparatus, as now applied, is already of enormous value in preventing accidents; and it will have a still greater effect on the general safety of railway travelling as it becomes more extensively applied on the older lines. Without it, a signalman in constantly working points and signals is almost certain sooner or later to make a mistake, and to cause an accident of a more or less serious character; and it is inexcusable in any railway company to allow its mail or express trains to run at high speed through facing points which are not interlocked efficiently with the signals, by which alone the engine-drivers in approaching them can be guided. There is however, very much yet to be effected in different parts of the country in this respect. And it is worth while to record here, in illustration of the difficulties that are sometimes met with by the inspecting officers, that the Midland Railway Company formally protested in June, 1866, against being compelled to apply such apparatus before receiving sanction for the opening of new lines of railway. They stated that in complying with the requirements in this respect of the Board of Trade, they '*were acting in direct opposition to their own convictions, and they must, so far as lay in their power, decline the responsibility of the locking system.*'"

In spite of any theoretical or fanciful objections which may be urged against it, this appliance will be found an indispensable adjunct to any really heavy junction or terminal train movement. For the elevated railroads of New York, for instance, its early adoption proved a necessity. As for questions of temperature, climate, etc., as affecting the long connecting rods and wires which are an essential part of the system, objections based upon them are purely imaginary. Difficulties from this source were long since met and overcome by very simple compensating arrangements, and in practice occasion no inconvenience. That rods may break, and that wires are at all times liable to get out of gear, every one knows; and yet this fact is urged as a novel objection to each new mechanical improvement. That a broken or disordered apparatus will always occasion a serious disturbance to any heavy train movement, may also be admitted. The fact none the less remains that in practice, and daily subjected through long periods of time to incomparably the heaviest train movement known to railroad experience, the rods of the interlocking apparatus do not break, nor do it's wires get out of

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To still further perfect the appliance a simple mechanism has since 1870 been attached to the rod actuating the switch-bolt, which prevents the signal-man from shifting the switch under a passing train in the manner suggested by Captain Tyler in the above extract. In fact it is no exaggeration to say that the interlocking system has now been so studied, and every possible contingency so thoroughly provided for, that in using it accidents can only occur through a wilful intention to bring them about.

gear; while by means of it, and of it alone, this train movement goes unceasingly on never knowing any serious disturbance.*

It is not, however, alone in connection with terminal stations and junctions that the interlocking apparatus is of value. It is also the scientific substitute for the law or regulation compelling trains to stop as a measure of precaution when they approach grade-crossings or draw-bridges. It is difficult indeed to pass from the consideration of this fine result of science and to speak with patience of the existing American substitute for it. If the former is a feature in the block system, the latter is a signal example of the block-head system. As a device to avoid danger it is a standing disgrace to American ingenuity; and, fortunately, as stopping is compatible only with a very light traffic, so soon as the passage of trains becomes incessant a substitute for it has got to be devised. In this country,

* "As an instance of the possibility of preventing the mistakes so often made by signal men with conflicting signals or with facing points I have shown the traffic for a single day, and at certain hours of that day, at the Cannon Street station of the South Eastern Railway, already referred to as one of the *no-accident* lines of the year. The traffic of that station, with trains continually crossing one another, by daylight and in darkness, in fog or in sunshine, amounts to more than 130 trains in three hours in the morning, and a similar number in the evening; and, altogether, to 652 trains, conveying more than 35,000 passengers in the day as a winter, or 40,000 passengers a day as a summer average. It is probably not too much to say, that without the signal and point arrangements which have there been supplied, and the system of interlocking which has there been so carefully carried out, the signalmen could not carry on their duties *for one hour without accident.*" *Captain Tyler's report on accidents for* 1870, *p.* 35.

as in England, that substitute will be found in the interlocking apparatus. By means of it the draw-bridge, for instance, can be so connected with the danger signals—which may, if desired, be gates closing across the railroad tracks—that the one cannot be opened except by closing the other. This is the method adopted in Great Britain not only at draws in bridges, but frequently also in the case of gates at level road crossings. It has already been noticed that in Great Britain accidents at draws in bridges seem to be unknown. Certainly not one has been reported during the last nine years. The security afforded in this case by interlocking would, indeed, seem to be absolute; as, if the apparatus is out of order, either the gates or the bridge would be closed, and could not be opened until it was repaired. So also as respects the grade-crossing of one railroad by another. Bringing all trains to a complete stop when approaching these crossings is a precaution quite generally observed in America, either as a matter of statute law or running regulation; and yet during the six years 1873–8 no less than 104 collisions were reported at these crossings. In Great Britain during the nine years 1870–8 but nine cases of accidents of this description were reported, and in both the years 1877 and 1878 under the head of "Accidents or Collisions on Level Crossings of Railways," the chief inspector of the Board of Trade tersely stated that,—"No accident was inquired into under this

head.*" The interlocking system there affords the most perfect protection which can be devised against a most dangerous practice in railroad construction to which Americans are almost recklessly addicted. It is, also, matter of daily eperience that the interlocking system does afford a perfect practical safeguard in this case. Every junction of a branch with a double track road involves a grade-crossing, and a grade-crossing of the most dangerous character. On the Metropolitan Elevated railroad of New York, at 53d street, there is one of these junctions, where, all day long, trains are crossing at grade at the rate of some twenty miles an hour. These trains never stop, except when signalled so to do. The interlocking apparatus, however, makes it impossible that one track should be open except when the other is closed. An accident, therefore, can happen only through the wilful carelessness of the engineer in charge of a train;—and in the face of wilful carelessness laws are of no more avail than signals. If a man in control of a locomotive wishes to bring on a collision he can always do it. Un-

* "As affecting the safe working of railways, the level crossing of one railway by another is a matter of very serious import. Even when signalled on the most approved principles, they are a source of danger, and, if possible, should always be avoided. At junctions of branch or other railways the practice has been adopted by some companies in special cases, to carry the off line under or over the main line by a bridge. This course should generally be adopted in the case of railways on which the traffic is large, and more expressly where express and fast trains are run." *Report on Accidents on Railways of the United Kingdon during* 1877, *p.* 35.

less he wishes to, however, the interlocking apparatus not only can prevent him from so doing, but as a matter of fact always does. The same rule which holds good at junctions would hold good at level crossings. There is no essential difference between the two. By means of the interlocking apparatus the crossing can be so blocked at any desired distance from it in such a way that when one track is open the other must be closed;—unless, indeed, the apparatus is out of order, and then both would be closed. The precaution in this case, also, is absolute. Unlike the rule as to stopping, it does not depend on the caution or judgment of individuals;—there are the signals and the obstructions, and if they are not displayed on one road they are on the other. So superior is this apparatus in every respect—as regards safety as well as convenience—to the precaution of coming to a stop, that, as an inducement to introduce an almost perfect scientific appliance, it would be very desirable that states like Massachusetts and Connecticut compelling the stop, should except from the operation of the law all draw-bridges or grade-crossings at which suitable interlocking apparatus is provided. Surely it is not unreasonable that in this case science should have a chance to assert itself.

In any event, however, the general introduction of the interlocking apparatus into the American railroad system may be regarded as a mere question of the value of land and concentration of traffic. So long as every road terminating in our larger cities

indulges, at whatever unnecessary cost to its stockholders, in independent station buildings far removed from business centres, the train movement can most economically be conducted as it now is. The expense of the interlocking apparatus is avoided by the very simple process of incurring the many fold heavier expense of several station buildings and vast disconnected station grounds. If, however, in the city of Boston, for instance, the time should come when the financial and engineering audacity of the great English companies shall be imitated,—when some leading railroad company shall fix its central passenger station on Tremont street opposite the head of Court street, just as in London the South Eastern established itself on Cannon street, and then this company carrying its road from Pemberton Square by a tunnel under Beacon Hill and the State-house should at the crossing of the Charles radiate out so as to afford all other roads an access for their trains to the same terminal point, thus concentrating there the whole daily movement of that busy population which makes of Boston its daily counting-room and market-place,—then, when this is attempted, the time will have come for utilizing to its utmost capacity every available inch of space to render possible the incessant passage of trains. Then also will it at last be realized that it is far cheaper to use a costly and intricate apparatus which enables two companies to be run into one convenient station, than it is to build a separate station, even at an inconvenient point, to accommodate each company.

CHAPTER XIX.

THE WESTINGHOUSE BRAKE.

IN March, 1825, there appeared in the pages of the *Quarterly Review* an article in which the writer discussed that railway system, the first vague anticipation of which was then just beginning to make the world restless. He did this, too, in a very intelligent and progressive spirit, but unfortunately secured for his article a permanence of interest he little expected by the use of one striking illustration. He was peculiarly anxious to draw a distinct line of demarcation between his own very rational anticipations and the visionary dreams of those enthusiasts who were boring the world to death over the impossibilities which they claimed that the new invention was to work. Among these he referred to the proposition that passengers would be "whirled at the rate of eighteen or twenty miles an hour by means of a high pressure engine," and then contemptuously added,—"We should as soon expect

the people of Woolwich to suffer themselves to be fired off upon one of Congreve's *ricochet* rockets, as trust themselves to the mercy of such a machine, going at such a rate; their property perhaps they may trust."

Under the circumstances, the criticism was a perfectly reasonable one. The danger involved in going at such a rate of speed and the impossibility of stopping in time to avoid a sudden danger, would naturally suggest themselves to any one as insuperable objections to the new system for any practical use. Some means of preserving a sudden and powerful control over a movement of such unheard of rapidity would almost as a matter of course be looked upon as a condition precedent. Yet it is a most noticeable fact in the history of railroad development that the improvement in appliances for controlling speed by no means kept pace with the increased rate of speed attained. Indeed, so far as the possibility of rapid motion is concerned, there is no reason to suppose that the *Rocket* could not have held its own very respectably by the side of a passenger locomotive of the present day. It will be remembered that on the occasion of the Manchester & Liverpool opening, Mr. Huskisson after receiving his fatal injury was carried seventeen miles in twenty-five minutes. Since then the details of locomotive construction have been simplified and improved upon, but no great change has been or probably will be effected in the matter of velocity;—

as respects that the maximum was practically reached at once. Yet down to the year 1870 the brake system remained very much what it was in 1830. Improvements in detail were effected, but the essential principles were the same. In case of any sudden emergency, the men in charge of the locomotive had no direct control over the vehicles in the train; they communicated with them by the whistle, and when the signal was heard the brakes were applied as soon as might be. When a train is moving at the rate of forty miles an hour, by no means a great speed for it while in full motion, it passes over fifty-eight feet each second;—at sixty miles an hour it passes over eighty-eight feet. Under these circumstances, supposing an engine driver to become suddenly aware of an obstruction on the track, as was the case at Revere, or of something wrong in the train behind him, as at Shipton, he had first himself to signal danger, and to this signal the brakemen throughout the train had to respond. Each operation required time, and every second of time represented many feet of space. It was small matter for surprise, therefore, that when in 1875 they experimented scientifically in England, it was ascertained that a train of a locomotive and thirteen cars moving at a speed of forty-five miles an hour could not be brought to a stand in less than one minute, or before it had traversed a distance of half a mile. The same result it will be remembered was arrived at by practical experience in America, where both at Angola

and at Port Jervis,* it was found impossible to stop the trains in less than half-a-mile, though in each case two derailed cars were dragging and plunging along at the end of them.

The need of a continuous train-brake, operated from the locomotive and under the immediate control of the engine-driver, had been emphasized through years by the almost regular recurrence of accidents of the most appalling character. In answer to this need almost innumerable appliances had been patented and experimented with both in Europe and in America. Prior to 1869, however, these had been almost exclusively what are known as emergency brakes;—that is, although the trains were equipped with them and they were operated from the locomotives, they were not relied upon for ordinary use, but were held in reserve, as it were, against special exigencies. The Hudson River railroad train at the Hamburg accident was thus equipped. Practically, appliances which in the operation of railroads are reserved for emergencies are usually found of little value when the emergency occurs. Accordingly no continuous brake had, prior to the development of Westinghouse's invention, worked its way into general use. Patent brakes had become a proverb as well as a terror among railroad mechanics, and they had ceased to believe that any really desirable thing of the sort would ever be perfected. Westinghouse, therefore, had a most unbelieving audience to encounter, and

* *Ante*, pp. 15, 119.

his invention had to fight hard for all the favor it won; nor did his experience with master mechanics differ, probably, much from Miller's. His first patents were taken out in 1869, and he early secured the powerful aid of the Pennsylvania road for his invention. The Pullman Car Company, also, always anxious to avail themselves of every appliance of safety as well as of comfort, speedily saw the merits of the new brake and adopted it; but, as they merely furnished cars and had nothing to do with the locomotives that pulled them, their support was not so effective as that of the great railroad company. Naturally enough, also, great hesitation was felt in adopting so complicated an appliance. It added yet another whole apparatus to a thing which was already overburdened with machinery. There was, also, something in the delicacy and precision of the parts of this new contrivance,—in its air-pump and reservoirs and long connecting tubes with their numerous valves,—which was peculiarly distasteful to the average practical railroad mechanic. It was true that the idea of transmitting power by means of compressed air was by no means new,—that thousands of drills were being daily driven by it wherever tunnelling was going on or miners were at work,—yet the application of this familiar power to the wheels of a railroad train seemed no less novel than it was bold. It was, in the first place, evident that the new apparatus would not stand the banging and

hammering to which the old-fashioned hand-brake might safely be subjected; not indeed without deranging that simple appliance, but without incurring any very heavy bill for repairs in so doing. Accordingly the new brake was at first carelessly examined and patronizingly pushed aside as a pretty toy,—nice in theory no doubt, but wholly unfitted for rough, every-day use. As it was tersely expressed during a discussion before the Society of Arts in London, as recently as May, 1877,—"It was no use bringing out a brake which could not be managed by ordinary officials,—which was so wonderfully clever that those who had to use it could not understand it." A line of argument by the way, which, as has been already pointed out, may with far greater force be applied to the locomotive itself; and, indeed, unquestionably was so applied about half a century ago by men of the same calibre who apply it now, to the intense weariness and discouragement no doubt of the late George Stephenson. Whether sound or otherwise, however, few more effective arguments against an appliance can be advanced; and against the Westinghouse brake it was advanced so effectively, that even as late as 1871, although largely in use on western roads, it had found its way into Massachusetts only as an ingenious device of doubtful merit. It was in August, 1871, that the Revere disaster occurred, and the Revere disaster, as has been seen, would unquestionably have been averted had the colliding

train been provided with proper brake power. This at last called serious attention there to the new appliance. Even then, however, the mere suggestion of something better being in existence than the venerable hand-brakes in familiar use did not pass without a vigorous protest; and at the meeting of railroad officials, which has already been referred to as having been called by the state commissioners after the accident, one prominent gentleman, when asked if the road under his charge was equipped with the most approved brake, indignantly replied that it was,—that it was equipped with the good, old-fashioned hand-brake;—and he then proceeded to vehemently stake his professional reputation on the absolute superiority of that ancient but somewhat crude appliance over anything else of the sort in existence. Nevertheless, on this occasion also, the great dynamic force which is ever latent in first-class railroad accidents again asserted itself. Even the most opinionated of professional railroad men, emphatically as he might in public deny it, quietly yielded as soon as might be. In a surprisingly short time after the exhibition of ignorance which has been referred to, the railroads in Massachusetts, as it has already been shown, were all equipped with train-brakes.*

In its present improved shape it is safe to say that in all those requisites which the highest authorities known on the subject have laid down as

* Page 157.

essential to a model train brake, the Westinghouse stands easily first among the many inventions of the kind. It is now a much more perfect appliance than it was in 1871, for it was then simply atmospheric and continuous in its action, whereas it has since been made automatic and self-regulating. So far as its fundamental principle is concerned, that is too generally understood to call for explanation. By means of an air-pump, attached to the boiler of the locomotive and controlled by the engine-driver, an atmospheric force is brought to bear, through tubes running under the cars, upon the break blocks, pressing them against the wheels. The hand of the engine-driver is in fact on every wheel in the train. This application of power, though unquestionably ingenious and, like all good things, most simple and obvious when once pointed out, was originally open to one great objection, which was persistently and with great force urged against it. The parts of the apparatus were all delicate, and some injury or derangement of them was always possible, and sometimes inevitable. The chief advantage claimed for the brake was, however, that complete dependence could be placed upon it in the regular movement of trains. It was obvious, therefore, that if such dependence was placed upon it and any derangement did occur, the first intimation those in charge of the train would have that something was wrong might well come in the shape of a failure of the brake to act, and a subsequent

disaster. Both in Massachusetts and in Connecticut, at the crossing of one railroad by another at the same level in the former state and in the approach to draws in bridges in the latter, a number of cases of this failure of the original Westinghouse non-automatic brake to act did in point of fact occur. Fortunately they, none of them, resulted in disaster. This, however, was mere good luck, as was illustrated in the case of the accident of November 11, 1876, at the Communipaw Ferry on the New Jersey Central. The train was there equipped with the ordinary train brake. It reached Jersey City on time shortly after 4 P.M., but, instead of slacking up, it ran directly through the station and freight offices, carrying away the walls and supports, and the locomotive then plunged into the river beyond. The baggage and smoking car followed but fortunately lodged on the locomotive, thus blocking the remainder of the train. Fortunately no one was killed, and no passengers were seriously injured.

Again, on the Metropolitan Elevated railroad in New York city, on the evening of June 23, 1879, one of the trains was delayed for a few moments at the Franklin street station. Meanwhile the next train came along, and, though the engine-driver of this following train saw the danger signals and endeavored to stop in time, he found his brake out of order, and a collision ensued resulting in the injury of one employé and the severe shattering of a pas-

senger coach and locomotive. It was only a piece of good fortune that the first of these accidents did not result in a repetition of the Norwalk disaster and the second in that of Revere.

It so chanced that it was the Smith vacuum brake which failed to work at Communipaw, and the Eames vacuum which failed to work at Franklin street. This, however, was wholly immaterial. It might just as well have been the original Westinghouse. The difficulty lay, not in the maker's name, but in the imperfect action of the brake; and such significant intimations are not to be disregarded. The chances are naturally large that the failure of the continuous brake to act will not at once occur under just those circumstances which will entail a serious disaster and heavy loss of life; that, however, if such intimations as these are disregarded, it will sooner or later so occur does not admit of doubt.

But the possibility that upon some given occasion it might fail to work was not the only defect in the original Westinghouse; it might well be in perfect order and in full action even, and then suddenly, as the result of derailment or separation of parts, the apparatus might be broken, and at once the shoes would drop from the wheels, and the vehicles of the disabled train would either press forward, or, on an incline, stop and run backwards until their unchecked momentum was exhausted. This appears to have been the case at Wollaston, and contri-

buted some of its most disastrous features to that accident.

To obviate these defects Westinghouse in 1872 invented what he termed a triple valve attachment, by means of which, if the thing can be so expressed, his brake was made to always stand at danger. That is, in case of any derangement of its parts, it was automatically applied and the train stopped. The action of the brake was thus made to give notice of anything wrong anywhere in the train. A noticeable case of this occurred on the Midland railway in England, when on the November 22, 1876, as the Scotch express was approaching the Heeley station, at a speed of some sixty miles an hour, the hind-guard felt the automatic brake suddenly self-applied. The forward truck of a Pullman car in the middle of the train had left the rails; the front part of the train broke the couplings and went on, while the rear carriages, acted upon by the automatic brakes, came to a stand immediately behind the Pullman, which finally rested on its side across the opposite track. There was no loss of life. On the other hand, as the Scotch express on the North Eastern road was approaching Morpeth, on March 25, 1877, at a speed of some twenty-five miles an hour, the locomotive for some reason left the track. The train was not equipped with an automatic brake, and the carriages in it accordingly pressed forward upon each other until three of them were so utterly destroyed as to be indis-

tinguishable. Five passengers lost their lives; the remains of one of whom, together with the wheels of a carriage, were afterwards taken out from the tank of the tender, into which they had been driven by the force of the shock.

The theoretical objection to the automatic brake is obvious. In case of any derangement of its machinery it applies itself, and, should these derangements be of frequent occurrence, the consequent stoppage of trains would prove a great annoyance, if not a source of serious danger. This objection is not sustained by practical experience.* The triple valve, so called, is the only complicated portion of the automatic brake, and this valve is well protected and not liable to get out of order.* Should it become deranged it will stop the working of the brake on that car alone to which it belongs; and it will become deranged so as to set the brake only from causes which would render the non-automatic brake inoperative. When anything of this

* Speaking of the modifications introduced into his brake by Westinghouse since 1874, Mr. Thomas E. Harrison, civil engineer of the North Eastern Railway Company in a communication to the directors of that company of April 24, 1879, recommending the adoption by it of the Westinghouse, and subsequently ordered to be printed for the use of Parliament, thus referred to the triple valve: "As the most important [of these modifications] I will particularly draw your attention to the "triple-valve" which has been made a regular bugbear by the opponents of the system, and has been called complicated, delicate, and liable to get out of order, etc. * * * It is, in fact, as simple a piece of mechanism as well can be imagined, certain in its action, of durable materials, easily accessible to an ordinary workman for examination or cleaning, and there is nothing about it that can justify the term complication; on the contrary, it is a model of ingenuity and simplicity."

sort occurs, it stops the train until the defect is remedied. The returns made to the English Board of Trade enable us to know just how frequently in actual and regular service these stoppages occur, and what they amount to. Take, for instance, the North Eastern and the Caledonian railways. Both use the automatic brake. During the last six months of 1878 the first ran 138,000 train miles with it, in the course of which there were eight delays or stoppages of some three to five minutes each occasioned by the action of the triple-valve; being in round numbers one occasion of delay in 17,000 miles of train movement. On the Caledonian railway, during the same period, four brake failures, due to the action of the triple-valve, were reported in runs aggregating over 62,000 miles, being about one failure to 15,000 miles. These failures moreover occasioned delays of only a few minutes each, and, where the cause of the difficulty was not so immediately apparent that it could at once be remedied, the brake-tubes of the vehicle on which the difficulty occurred were disconnected, and the trains went on.* One of these stop-

* During the six months ending June 30, 1879, some 300 stops due to some derangement of the apparatus of the Westinghouse brake were reported by ten companies in runs aggregating about two million miles. Being one stop to 6,600 miles run. Very many of these stops were obviously due to the want of familiarity of the employés with an apparatus new to them, but as a rule the delays occasioned did not exceed a very few minutes; of 82 stoppages, for instance, reported on the London, Brighton & South Coast road, the two longest were ten minutes each and the remainder averaged some three or four minutes.

pages, however, resulted in a serious accident. As a train on the Caledonian road was approaching the Wemyss Bay junction on December 14th, in a dense fog, the engine driver, seeing the signals at danger, undertook to apply his brake slightly, when it went full on, stopping the train between the distant and home signals, as they are called in the English block system. After the danger signal was lowered, but before the brake could be released, the signal-man allowed a following train to enter upon the same block section, and a collision followed in which some thirteen passengers were slightly injured. This accident, however, as the inspecting officer of the Board of Trade very properly found, was due not at all to the automatic brake, but to "carelessness on the part of the signal-man, who disregarded the rules for the working of the block telegraph instruments," and to the driver of the colliding train, who "disobeyed the company's running regulations." It gives an American, however, a realizing sense of one of the difficulties under which those crowded British lines are operated, to read that in this case the fog was "so thick that the tail-lamp was not visible from an approaching train for more than a few yards."

After the application of the triple valve had made it automatic, there remained but one further improvement necessary to render the Westinghouse a well-nigh perfect brake. A superabundance of self-acting power had been secured, but no provision was

yet made for graduatiug the use of that power so that it should be applied in the exact degree, neither more nor less, which would soonest stop the train. This for two reasons is mechanically a matter of no little importance. As is well known a too severe application of brakes, no matter of what kind they are, causes the wheels to stand still and slide upon the rails. This is not only very injurious to rolling stock, the wheels of which are flattened at the points which slide, but, as has long been practically well-known to those whose business it is to run locomotives, when once the wheels begin to slide the retarding power of the brakes is seriously diminished. In order, therefore, to secure the maximum of retarding power, the pressure of the brake-blocks on the revolving wheels should be very great when first applied, and just sufficient not to slide them; and should then be diminished, *pari passu* with the momentum of the train, until it wholly stops. Familiar as all this has long been to engine-drivers and practical railroad mechanics, yet it has not been conceded in the results of many scientific inquiries. In the report of one of the Royal Commissions on Accidents, for instance, it was asserted that the momentum of a train was retarded more by the action of sliding than of slowly revolving wheels; and again, as recently as in May, 1877, in a scientific discussion in London at one of the meetings of the Society of Arts, a gentleman, with the letters C. E. appended to his name, ventured

the surprising assertion that "no brake could do more than skid the wheels of a train, and all continuous brakes professed to do this, and he believed did so about equally well." Now, what it is here asserted no brake can do is exactly what the perfect brake will be made to do,—and what Westinghouse's latest improvement, it is claimed, enables his brake to do. It much more than "skids the wheels," by measuring out exactly that degree of power necessary to hold the wheels just short of the skidding point, and in this way always exerts the maximum retarding force. This is brought about by means of a contrivance which allows the air to leak out of the brake cylinders so as to exactly proportion the pressure of the blocks on the wheels to the speed with which the latter are revolving. In other, and more scientific, language the force with which the brake-blocks are pressed upon the wheels is made to adjust itself automatically as the "coefficient of dynamic friction augments with the reduction of train speed." It hardly needs to be said that in this way the power of the brake is enormously increased.

In America the superiority of the Westinghouse over any other description of train-brake has long been established through that large preponderance of use which in such matters constitutes the final and irreversible verdict.* In Europe, however, and

* In Massachusetts, for instance, where no official pressure in favor of any particular brake was brought to bear, out of 473 locomotives

especially in Great Britain, ever since the Shipton-on-Cherwell accident in 1874, the battle of the brakes, as it may not inappropriately be called, has waxed hotter and hotter; and not only has this battle been extremely interesting in a scientific way, but it has been highly characteristic, and at times enlivened by touches of human nature which were exceedingly amusing.

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equipped with train-brakes 361 have the Westinghouse, which is also applied to 1,363 out of 1,669 cars. Of these, however, 79 locomotives and 358 cars are equipped with both the atmospheric and the vacuum brakes.

CHAPTER XX.

THE BATTLE OF THE BRAKES.

THE English battle of the brakes may be said to have fairly opened with the official report from Captain Tyler on the Shipton accident, in reference to which he expressed the opinion, which has already been quoted in describing the accident, that "if the train had been fitted with continuous brakes throughout its whole length there is no reason why it should not have been brought to rest without any casuality." The Royal Commission on railroad accidents then took the matter up and called for a series of scientifically conducted experiments. These took place under the supervision of two engineers appointed by the Commission, who were aided by a detail of officers and men from the royal engineers. Eight brakes competed, and a train, consisting of a locomotive and thirteen cars, was specially prepared for each. With these trains some seventy runs were made, and

their results recorded and tabulated; the experiments were continued through six consecutive working days. Of the brakes experimented with three were American in their origin,—Westinghouse's automatic and vacuum, and Smith's vacuum. The remainder were English, and were steam, hydraulic, and air brakes; among them also was one simple emergency brake. The result of the trials was a very decided victory for the Westinghouse automatic, and upon its performances the Commission based its conclusion that trains ought to be so equipped that in cases of emergency they could be brought to rest, when travelling on level ground at 50 miles an hour, within a distance of 275 yards; with an allowance of distance in cases of speed greater or less than 50 miles nearly proportioned to its square. These allowances they tabulated as follows:—

At 60 miles per hour,	stopping	distance	within	400 yards.
" 55	"	"	340	"
" 50	"	"	275	"
" 45	"	"	220	"
" 40	"	"	180	"
" 35	"	"	135	"
" 30	"	"	100	"

To appreciate the enormous advance in what may be called stopping power which these experiments revealed, it should be added that the first series of experiments made at Newark were with trains equipped only with the hand-brake. The average

speed in these experiments was 47 miles, and with the train-brake, according to the foregoing tabulation, the stop should have been made in about 250 yards; in reality it was made in a little less than five times that distance, or 1120 yards; in other words the experiments showed that the improved appliances had more than quadrupled the control over trains. It has already been noticed that in the cases of the Angola and the Port Jervis disasters, as well as in that at Shipton, the trains ran some 2,700 feet before they could be stopped. Under the English tabulations above given, in the results of which certain recent improvements do not enter, a train running into the 42d Street Station in New York, at a speed of forty-five miles an hour when under the entrance arches, would be stopped before it reached the buffers at the end of the covered tracks.

The Royal Commission experiments were followed in May and June, 1877, by yet others set on foot by the North Eastern Railway Company for the purpose of making a competitive test of the Westinghouse automatic and the Smith's vacuum brakes. At this trial also the average stop at a speed of 50 miles an hour was effected in 15 seconds, and within a distance of 650 feet. Other series of experiments with similar results were, about the same time, conducted under the auspices of the Belgian and German governments, of which elaborate official reports were made. The result was that at last, under date

of August 30, 1877, the Board of Trade issued a circular to the railway companies in which it called attention to the fact that, notwithstanding all the discussion which had taken place and the elaborate official trials which the government had set on foot, there had "apparently been no attempt on the part of the various companies to take the first step of agreeing upon what are the requirements which, in their opinion, are essential to a good continuous brake." In other words, the Board found that, instead of becoming better, matters were rapidly becoming worse. Each company was equipping its rolling stock with that appliance in which its officers happened to be interested as owners or inventors, and when carriages thus equipped passed from the tracks of one road onto those of another the result was a return to the old hand-brake system in a condition of impaired efficiency. The Board accordingly now proceeded to narrow down the field of selection by specifying the following as what it considered the essentials of a good continuous brake :—

a. "The brakes to be efficient in stopping trains, instantaneous in their actions, and capable of being applied without difficulty by engine-drivers or guards.

b. "In case of accident, to be instantaneously self-acting.

c. "The brakes to be put on and taken off (with facility) on the engine and on every vehicle of a train.

d. "The brakes to be regularly used in daily working.

e. "The materials employed to be of a durable character, so as to be easily maintained and kept in order."

These requirements pointed about as directly as they could to the Westinghouse, to the exclusion of all competing brakes. Not more than one other complied with them in all respects, and many made no pretence of complying at all. Then followed what may be termed the battle royal of the brakes, which as yet shows no signs of drawing to a close. As the avowed object of the Board of Trade was to introduce one brake, to the necessary exclusion of all others, throughout the railroad system of Great Britain, the magnitude of the prize was not easy to over-estimate. The weight of scientific and official authority was decidedly in favor of the Westinghouse automatic, but among the railroad men the Smith vacuum found the largest number of adherents. It failed to meet three of the requirements of the Board of Trade, in that it was neither automatic nor instantaneous in its action, while the materials employed in it were not of a durable character. It was, on the other hand, a brake of unquestioned excellence, while it commended itself to the judgment of the average railroad official by its simplicity, and to that of the average railroad director by its apparent cheapness. Any one could understand it, and its first cost was temptingly small. The real struggle in Great Britain, therefore, has been, and now is, between these two brakes; and the fact that both of them are American has been made to enter largely into it, and in a way also which at times lent to the discussion an element of broad humor.

For instance, the energetic agent of the Smith vacuum, feeling himself aggrieved by some statement which appeared in the *Times*, responded thereto in a circular, in the composition of which he certainly evinced more zeal than either judgment or literary skill. This circular and its author were then referred to by the editors of *Engineering*, a London scientific journal, in the following slightly *de haut en bas* style :—

"It is not a little remarkable, and it is a fact not harmonious with the feelings of English engineers, that the two brakes recommending themselves for adoption are of American origin. * * * Now we cannot wonder, considering what our past experience has been in many of our dealings with Americans, that this feeling of distrust and prejudice exists. It is not merely sentimental, it is founded on many and untoward and costly experiences of the past, and the fear of similar experiences in the future. And when we see the representative of one of these systems adopting the traditional policy of his country, and meeting criticism with abuse—abuse of men pre-eminent in the profession, and journals which he apparently forgets are neither American nor venal—we do not wonder that our railway engineers feel a repugnance to commit themselves."

The superiority of the British over the American controversialist, as respects courtesy and restraint in language, being thus satisfactorily established, it only remained to illustrate it. This, however, had already been done in the previous May; for at that time it chanced that Captain Tyler, having retired from his position at the head of the railway inspec-

tors department of the Board of Trade, was considering an offer which Mr. Westinghouse had made him to associate himself with the company owning the brakes known by that name. Before accepting this offer, Captain Tyler took advantage of a meeting of the Society of Arts to publicly give notice that he was considering it. This he did in a really admirable paper on the whole subject of continuous brakes, at the close of which a general discussion was invited and took place, and in the course of it the innate superiority of the British over any other kind of controversialist, so far at least as courtesy and a delicate refraining from imputations is concerned, received pointed illustration.

No sooner had Captain Tyler finished than Mr. Houghton, C. E., took occasion to refer to the paper he had read as "an elaborate puff to the Westinghouse brake, with which he [Tyler] was, as he told, connected, or about to be." Subsequently Mr. Steele proceeded to say that:—

"On receiving the invitation to be present at the meeting, he had been somewhat afraid that Captain Tyler was going to lose his fine character for impartiality by throwing in his lot with the brake-tinkers, but it came out that not only was he going to do that, but actually going to be a partner in a concern. * * * The speaker then proceeded to discuss the Westinghouse brake, which he called the Westinghouse and Tyler brake, designating it as a jack-in-the-box, a rattle trap, to please and decoy, and not an invention at all. No engineer had a hand in its manufacture. It was the discovery of some Philadelphia barber or some such thing.

He had spoken of honest brakes. This was a brake which had all sorts of pretensions. It had not worked well, but whenever there was any row about its not working well, they got the papers to praise it up, and that was how the papers were under the thumb, and would not speak of any other. * * * He thought it would not do for railway companies to take a bad brake, and Captain Tyler and Mr. Westinghouse be able to make their fortunes by floating a limited company for its introduction. They had heard of Emma mines and Lisbon tramways, and such like, and he felt it would not be well to stand by and allow this to be done."

All of which was not only to the point, but finely calculated to show the American inventors and agents who were present the nice and mutually respectful manner in which such discussions were carried on by all Englishmen.

Though the avowed adhesion of Sir Henry Tyler to the Westinghouse was a most important move in the war of the brakes, it did not prove a decisive one. The complete control of the field was too valuable a property to be yielded in deference to that, or any other name without a struggle; and, so to speak, there were altogether too many ins and outs to the conflict. Back door influences had everywhere to be encountered. The North Western, for instance, is the most important of the railway companies of the United Kingdom. The locomotive superintendent of that company was the part inventor and proprietor of an emergency brake which had been extensively adopted by it on its rolling stock, but which wholly failed to meet the re-

quirements laid down in its circular by the Board of Trade. Immediately after issuing that circular the Board of Trade called the attention of the company to this fact in connection with an accident which had recently occurred, and in very emphatic language pointed out that the brakes in question could not "in any reasonable sense of the word be called continuous brakes," and that it was clear that the circular requirements were "not complied with by the brake-system of the London & North Western Railway Company;" in case that company persisted in the use of that brake, the secretary of the Board went on to say, "in the event of a casualty occurring, which an efficient system of brakes might have prevented, a heavy personal responsibility will rest upon those who are answerable for such neglect." This was certainly language tolerably direct in its import. As such it was calculated to cause those to whom it was addressed to pause in their action. The company, however, treated it with a superb disregard, all the more contemptuous because veiled in language of deferential civility. They then quietly went on applying their locomotive superintendent's emergency brake to their equipment, until on the 30th of June, 1879, they returned no less than 2,052 carriages fitted with it; that being by far the largest number returned by any one company in the United Kingdom.

A more direct challenge to the Board of Trade

and to Parliament could not easily have been devised. To appreciate how direct it was, it is necessary to bear in mind that in its circular of August 30, 1877, in which the requirements of a satisfactory train-brake were laid down, the Board of Trade threw out to the companies the very significent hint, that they "would do well to reflect that if a doubt should arise that from a conflict of interest or opinion, or from any other cause, they [the companies] are not exerting themselves, it is obvious that they will call down upon themselves an interference which the Board of Trade, no less than the companies, desire to avoid." In his general report on the accidents of the year 1877, the successor of Captain Tyler expressed the opinion that "sufficient information and experience would now appear to be available, and the time is approaching when the railway companies may fairly be expected to come to a decision as to which of the systems of continuous brakes is best calculated to fulfil the requisite conditions, and is most worthy of general adoption." At the close of another year, however, the official returns seemed to indicate that, while but a sixth part of the passenger locomotives and a fifth part of the carriages in use on the railroads of the United Kingdom were yet equipped with continuous brakes at all, a concurrence of opinion in favor of any one system was more remote than ever. During the six months ending December 31, 1878, but 127 additional locomotives out of

about 4000, and 1,200 additional carriages out of some 32,000 were equipped; of which 70 locomotives and 530 carriages had been equipped with the Smith vacuum, which in three most important respects failed to comply with the Board of Trade requirements. Under these circumstances the Board of Trade was obviously called upon either to withdraw from the position it had taken, or to invite that "interference" in its support to which in its circular of August, 1877 it had so portentously referred. It decided to do the latter, and in March, 1879 the government gave an intimation in the House of Lords that early Parliamentary action was contemplated. As it is expressed, the railway companies are to "be relieved of their indecision."

In Great Britian, therefore, the long battle of the brakes would seem to be drawing to its close. The final struggle, however, will be a spirited one, and one which Americans will watch with considerable interest,—for it is in fact a struggle between two American brakes, the Westinghouse and the Smith vacuum. Of the 907 locomotives hitherto equipped with the continuous brakes no less than 819 are equipped with one or the other of these American patents, besides over 4,464 of the 9,919 passenger carriages. The remaining 3,857 locomotives and 30,000 carriages are the prize of victory. As the score now stands the vacuum brake is in almost exactly twice the use of its more scientific rival.

The weight of authority and experience, and the requirements of the Board of Trade, are, however, on the opposite side.

As deduced from the European scientific tests and the official returns, the balance of advantages would seem to be as follows:—In favor of the vacuum are its superficial simplicity, and possible economy in first cost:—In favor of the Westinghouse automatic are its superior quickness in application, the greater rapidity in its stopping power, the more durable nature of its materials, the smaller cost in renewal, its less liability to derangement, and above all its self-acting adjustment. The last is the point upon which the final issue of the struggle must probably turn. The use of any train-brake which is not automatic in its action, as has already been pointed out, involves in the long run disaster,—and ultimate serious disaster. The mere fact that the brake is generally so reliable,—that ninety-nine times out of the hundred it works perfectly,—simply makes disaster certain by the fatal confidence it inspires. Ninety-nine times in a hundred the brake proves reliable;—nine times in the remaining ten of the thousand, in which it fails, a lucky chance averts disaster;—but the thousandth time will assuredly come, as it did at Communipaw and on the New York Elevated railway, and, much the worst of all yet, at Wollaston. Soon or late the use of non-automatic continuous brakes will most assuredly, if they are not sooner abandoned, be put an end to

by the occurrence of some not-to-be forgotten catastrophe of the first magnitude, distinctly traceable to that cause. Meanwhile that automatic brakes are complicated and sometimes cause inconvenience in their operation is most indisputable. This is an objection, also, to which they are open in common with most of the riper results of human ingenuity; —but, though sun-dials are charmingly simple, we do not, therefore, discard chronometers in their favor; neither do we insist on cutting our harvests with the scythe, because every man who may be called upon to drive a mowing machine may not know how to put one together. But what Sir Henry Tyler has said in respect to this oldest and most fallacious, as well as most wearisome, of objections covers the whole ground and cannot be improved upon. After referring to the fact that simplicity in construction and simplicity in working were two different things, and that, almost invariably, a certain degree of complication in construction is necessary to secure simplicity in working,— after pointing this out he went on to add that,—

"Simplicity as regards the application of railway brakes is not obtained by the system now more commonly employed of brake-handles to be turned by different men in different parts of the train; but is obtained when, by more complicated construction an engine-driver is able easily in an instant to apply ample brake-power at pleasure with more or less force to every wheel of his train; is obtained when, every time an engine-driver starts, or attempts to start his train, the brake itself informs him if

it is out of order; and is still more obtained when, on the occasion of an accident and the separation of a coupling, the brakes will unfailingly apply themselves on every wheel of the train without the action of the engine-driver or guards, [brakemen], and before even they have time to realize the necessity for it. This is true simplicity in such a case, and that system of continuous brakes which best accomplishes such results in the shortest space of time is so far preferable to all others."

CHAPTER XXI.

THE RAILROAD JOURNEY RESULTING IN DEATH.

ONE day in May, 1847, as the Queen of Belgium was going from Verviers to Brussels by rail, the train in which she was journeying came into collision with another train going in the opposite direction. There was naturally something of a panic, and, as royalty was not then accustomed to being knocked about with railroad equality, some of her suite urged the queen to leave the train and to finish her journey by carriage. The contemporaneous court reporter then went on to say, in that language which is so peculiarly his own,—"But her Majesty, as courageously as discreetly, declined to set that example of timidity, and she proceeded to Brussels by the railway." In those days a very exaggerated idea was universally entertained of the great danger incident to travel by rail. Even then, however, had her Majesty, who was doubtless a very sensible woman, happened to be familiar with the

statistics of injuries received by those traveling respectively by rail and by carriage, she certainly never on any plea of danger would have been induced to abandon her railroad train in order to trust herself behind horse-flesh. By pursuing the course urged upon her, the queen would have multiplied her chances of accident some sixty fold. Strange as the statement sounds even now, such would seem to have been the fact. In proportion to the whole number carried, the accidents to passengers in "the good old days of stage-coaches" were, as compared to the present time of the railroad dispensation, about as sixty to one. This result, it is true, cannot be verified in the experience either of England or of this country, for neither the English nor we possess any statistics in relation to the earlier period; but they have such statistics in France, stretching over the space of more than forty years, and as reliable as statistics ever are. If these French statistics hold true in New England,—and considering the character of our roads, conveyances, and climate, their showing is more likely to be in our favor than against us,—if they simply hold true, leaving us to assume that stage-coach traveling was no less safe in Massachusetts than in France, then it would follow that to make the dangers of the rail of the present day equal to those of the highway of half a century back, some eighty passengers should annually be killed and some eleven hundred injured within the limits of Massachusetts alone. These

figures, however, represent rather more than fifty times the actual average, and from them it would seem to be not unfair to conclude that, notwithstanding the great increase of population and the yet greater increase in travel during the last half-century, there were literally more persons killed and injured each year in Massachusetts fifty years ago through accidents to stage-coaches than there are now through accidents to railroad trains.

The first impression of nine out of ten persons in no way connected with the operations of railroads would probably be found to be the exact opposite to this. A vague but deeply rooted conviction commonly prevails that the railroad has created a new danger; that because of it the average human being's hold on life is more precarious than it was. The first point-blank, bald statement to the contrary would accordingly strike people in the light not only of a paradox, but of a somewhat foolish one. Investigation, nevertheless, bears it out. The fact is that when a railroad accident comes, it is apt to come in such a way as to leave no doubt whatever in relation to it. It is heralded like a battle or an earthquake; it fills columns of the daily press with the largest capitals and the most harrowing details, and thus it makes a deep and lasting impression on the minds of many people. When a multitude of persons, traveling as almost every man now daily travels himself, meet death in such sudden and such awful shape, the event smites the imagination. Peo-

ple seeing it and thinking of it, and hearing and reading of it, and of it only, forget of how infrequent occurrence it is. It was not so in the olden time. Every one rode behind horses,—if not in public then in private conveyances,—and when disaster came it involved but few persons and was rarely accompanied by circumstances which either struck the imagination or attracted any great public notice. In the first place, the modern newspaper, with its perfect machinery for sensational exaggeration, did not then exist,—having itself only recently come in the train of the locomotive;—and, in the next place, the circle of those included in the consequences of any disaster was necessarily small. It is far otherwise now. For weeks and months the vast machinery moves along, doing its work quickly, swiftly, safely; no one pays any attention to it, while millions daily make use of it. It is as much a necessity of their lives as the food they eat and the air they breathe. Suddenly, somehow, and somewhere,—at Versailles, at Norwalk, at Abergele, at New Hamburg, or at Revere,—at some hitherto unfamiliar point upon an insignificant thread of the intricate iron web, an obstruction is encountered, a jar, as it were, is felt, and instantly, with time for hardly an ejaculation or a thought, a multitude of human beings are hurled into eternity. It is no cause for surprise that such an event makes the community in which it happens catch its breadth; neither is it unnatural that people should think more of the few who are killed, of

whom they hear so much, than of the myriads who are carried in safety and of whom they hear nothing. Yet it is well to bear in mind that there are two sides to that question also, and in no way could this fact be more forcibly brought to our notice than by the assertion, borne out by all the statistics we possess, that, irrespective of the vast increase in the number of those who travel, a greater number of passengers in stage-coaches were formerly each year killed or injured by accidents to which they in no way contributed through their own carelessness, than are now killed under the same conditions in our railroad cars. In other words, the introduction of the modern railroad, so far from proportionately increasing the dangers of traveling, has absolutely diminished them. It is not, after all, the dangers but the safety of the modern railroad which should excite our special wonder.

What is the average length of the railroad journey resulting in death by accident to a prudent traveler?—What is the average length of one resulting in some personal injury to him?—These are two questions which interest every one. Few persons, probably, start upon any considerable journey, implying days and nights on the rail, without almost unconsciously taking into some consideration the risks of accident. Visions of collision, derailment, plunging through bridges, will rise unbidden. Even the old traveler who has enjoyed a long immunity is apt at times, with some little apprehen-

sion, to call to mind the musty adage of the pitcher and the well, and to ask himself how much longer it will be safe for him to rely on his good luck. A hundred thousand miles, perhaps, and no accident yet!—Surely, on every doctrine of chances, he now owes to fate an arm or a leg;—perhaps a life. The statistics of a long series of years enable us, however, to approximate with a tolerable degree of precision to an answer to these questions, and the answer is simply astounding;—so astounding, in fact, that, before undertaking to give it, the question itself ought to be stated with all possible precision. It is this:—Taking all persons, who as passengers travel by rail,—and this includes all dwellers in civilized countries,—what number of journeys of the average length are safely accomplished, to each one which results in the death or injury of a passenger from some cause over which he had no control?—The cases of death or injury must be confined to passengers, and to those of them only who expose themselves to no unnecessary risk.

When approaching a question of this sort, statisticians are apt to assume for their answers an appearance of mathematical accuracy. It is needless to say that this is a mere affectation. The best results which can be arrived at are, after all, mere approximations, and they also vary greatly year by year. The body of facts from which conclusions are to be deduced must cover not only a definite area

of space, but also a considerable lapse of time. Even Great Britain, with its 17,000 miles of track and its hundreds of millions of annual passenger journeys, shows results which, one year with another, vary strangely. For instance, during the four years anterior to 1874, but one passenger was killed, upon an average, to each 11,000,000 carried; while in 1874 the proportion, under the influence of a succession of disasters, suddenly doubled, rising to one in every 5,500,000; and then again in 1877, a year of peculiar exemption, it fell off to one in every 50,000,000. The percentage of fatal casualties to the whole number carried was in 1847–9 five fold what it was in 1878. If such fluctuations reveal themselves in the statistics of Great Britain, those met with in the narrower field of a single state in this country might well seem at first glance to set all computation at defiance. During the ten years, for example, between 1861 and 1870, about 200,000,000 passengers were returned as carried on the Massachusetts roads, with 135 cases of injury to individuals. Then came the year of the Revere disaster, and out of 26,000,000 carried, no less than 115 were killed or injured. Seven years of comparative immunity then ensued, during which, out of 240,000,000 carried, but two were killed and forty-five injured. In other words, through a period of ten years the casualties were approximately as one to 1,500,000; then during a single year they rose to one in 250,000, or a seven-fold increase; and then

through a period of seven years they diminished to one in 3,400,000, a decrease of about ninety per cent.

Taking, however, the very worst of years,—the year of the Revere disaster, which stands unparalleled in the history of Massachusetts,—it will yet be found that the answer to the question as to the length of the average railroad journey resulting in death or in injury will be expressed, not in thousands nor in hundreds of thousands of miles, but in millions. During that year some 26,000,000 passenger journeys were made within the limits of the state, and each journey averaged a distance of about 13 miles. It would seem, therefore, that, even in that year, the average journey resulting in death was 11,000,000 miles, while that resulting either in death or personal injury was not less than 3,300,000.

The year 1871, however, represented by no means a fair average. On the contrary, it indicated what may fairly be considered an excessive degree of danger, exciting nervous apprehensions in the breasts of those even who were not constitutionally timid. To reach what may be considered a normal average, therefore, it would be more proper to include a longer period in the computation. Take, for instance, the nine years, 1871–79, during which alone has any effort been made to reach statistical accuracy in respect to Massachusetts railroad accidents. During those nine years, speak-

ing in round numbers and making no pretence at anything beyond a general approximation, some 303,000,000 passenger journeys of 13 miles each have been made on the railroads and within the state. Of these 51 have resulted in death and 308 in injuries to persons from causes over which they had no control. The average distance, therefore, traveled by all, before death happened to any one, was about 80,000,000 miles, and that travelled before any one was either injured or killed was about 10,800,000.

The Revere disaster of 1871, however, as has been seen, brought about important changes in the methods of operating the railroads of Massachusetts. Consequently the danger incident to railroad traveling was materially reduced; and in the next eight years (1872–9) some 274,000,000 passenger journeys were made within the limits of the state. The Wollaston disaster of October, 1878, was included in this period, during which 223 persons were injured and 21 were killed. The average journey for these years resulting in any injury to a passenger was close upon 15,000,000 miles, while that resulting in death was 170,000,000.

But it may fairly be asked,—What, after all, do these figures mean?—They are, indeed, so large as to exceed comprehension; for, after certain comparatively narrow limits are passed the practical infinite is approached, and the mere adding of a few more ciphers after a numeral conveys no new idea. On

the contrary, the piling up of figures rather tends to weaken than to strengthen a statement, for to many it suggests an idea of ridiculous exaggeration. Indeed, when a few years ago a somewhat similar statement to that just made was advanced in an official report, a critic undertook to expose the fallacy of it in the columns of a daily paper by referring to a case within the writer's own observation in which a family of three persons had been killed on their very first journey in a railroad car. It is not, of course, necessary to waste time over such a criticism as this. Railroad accidents continually take place, and in consequence of them people are killed and injured, and of these there may well be some who are then making their first journey by rail; but in estimating the dangers of railroad traveling the much larger number who are not killed or injured at all must likewise be taken into consideration. Any person as he may be reading this page in a railroad car may be killed or injured through some accident, even while his eye is glancing over the figures which show how infinitesimal his danger is; but the chances are none the less as a million to one that any particular reader will go down to his grave uninjured by any accident on the rail, unless it be occasioned by his or her own carelessness.

Admitting, therefore, that ill luck or hard fortune must fall to the lot of certain unascertainable persons, yet the chances of incurring that ill fortune are so small that they are not materially increased

by any amount of traveling which can be accomplished within the limits of a human life. So far from exhausting a fair average immunity from accident by constant traveling, the statistics of Massachusetts during the last eight years would seem to indicate that if any given person were born upon a railroad car, and remained upon it traveling 500 miles a day all his life, he would, with average good fortune, be somewhat over 80 years of age before he would be involved in any accident resulting in his death or personal injury, while he would attain the highly respectable age of 930 years before being killed. Even supposing that the most exceptional average of the Revere year became usual, a man who was killed by an accident at 70 years of age should, unless he were fairly to be accounted unlucky, have accomplished a journey of some 440 miles every day of his life, Sundays included, from the time of his birth to that of his death; while even to have brought him within the fair liability of any injury at all, his daily journey should have been some 120 miles. Under the conditions of the last eight years his average daily journey through the three score years and ten to entitle him to be killed in an accident at the end of them would be about 600 miles.

CHAPTER XXII.

THE RAILROAD DEATH RATE.

IN connection with the statistics of railroad casualties it is not without interest to examine the general vital statistics of some considerable city, for they show clearly enough what a large degree of literal truth there was in the half jocose proposition attributed to John Bright, that the safest place in which a man could put himself was inside a first-class railroad carriage of a train in full motion. Take the statistics of Boston, for instance, for the year 1878. During the four years 1875–8, it will be remembered, a single passenger only was killed on the railroads of Massachusetts in consequence of an accident to which he by his own carelessness in no way contributed.* The average number of persons annually injured, not fatally, during those years was about five.

* This period did not include the Wollaston disaster, as the Massachusetts railroad year closes on the last day of September. The Wollaston disaster occurred on the 8th of October, 1878, and was accordingly included in the next railroad year.

Yet during the year 1878, excluding all cases of mere injury of which no account was made, no less than 53 persons came to their deaths in Boston from falling down stairs, and 37 more from falling out of windows; seven were scalded to death in 1878 alone. In the year 1874 seventeen were killed by being run over by teams in the streets, while the pastime of coasting was carried on at a cost of ten lives more. During the five years 1874–8 there were more persons murdered in the city of Boston alone than lost their lives as passengers through the negligence of all the railroad corporations in the whole state of Massachusetts during the nine years 1871–8; though in those nine years were included both the Revere and the Wollaston disasters, the former of which resulted in the death of 29, and the latter of 21 persons. Neither are the comparative results here stated in any respect novel or peculiar to Massachusetts. Years ago it was officially announced in France that people were less safe in their own houses than while traveling on the railroads; and, in support of this somewhat startling proposition, statistics were produced showing fourteen cases of death of persons remaining at home and there falling over carpets, or, in the case of females, having their garments catch fire, to ten deaths on the rail. Even the game of cricket counted eight victims to the railroad's ten.

It will not, of course, be inferred that the cases of death or injury to passengers from causes beyond

their control include by any means all the casualities involved in the operation of the railroad system. On the contrary, they include but a very small portion of them. The experience of the Massachusetts roads during the seven years between September 30, 1871, and September 30, 1878, may again be cited in reference to this point. During that time there were but 52 cases of injury to passengers from causes over which they had no control, but in connection with the entire working of the railroad system no less than 1,900 cases of injury were reported, of which 1,008 were fatal; an average of 144 deaths a year. Of these cases, naturally, a large proportion were employés, whose occupation not only involves much necessary risk, but whose familiarity with risk causes them always to incur it even in the most unnecessary and foolhardy manner. During the seven years 293 of them were killed and 375 were reported as injured. Nor is it supposed that the list included by any means all the cases of injury which occurred. About one half of the accidents to employés are occasioned by their falling from the trains when in motion, usually from freight trains and in cold weather, and from being crushed between cars while engaged in coupling them together. From this last cause alone an average of 27 casualties are annually reported. One fact, however, will sufficiently illustrate how very difficult it is to protect this class of men from danger, or rather from themselves. As is well known, on

freight trains they are obliged to ride on the tops of the cars; but these are built so high that their roofs come dangerously near the bottoms of the highway bridges, which cross the track sometimes in close proximity to each other. Accordingly many unfortunate brakemen were killed by being knocked off the trains as they passed under these bridges. With a view to affording the utmost possible protection against this form of accident, a statute was passed by the Massachusetts legislature compelling the corporations to erect guards at a suitable distince from every overhead bridge which was less than eighteen feet in the clear above the track. These guards were so arranged as to swing lightly across the tops of the cars, giving any one standing upon them a sharp rap, warning him of the danger he was in. This warning rap, however, so annoyed the brakemen that the guards were on a number of the roads systematically destroyed as often as they were put up; so that at last another law had to be passed, making their destruction a criminal offense. The brakemen themselves resisted the attempt to divest their perilous occupation of one of its most insidious dangers.

In this respect, however, brakemen differ in no degree from the rest of the community. On all hands railroad accidents seem to be systematically encouraged, and the wonder is that the list of casualities is not larger. In Massachusetts, for instance, even in the most crowded portions of the largest

cities and towns, not only do the railroads cross the highways at grade, but whenever new thoroughfares are laid out the people of the neighborhood almost invariably insist upon their crossing the railroads at a grade and not otherwise. Not but that, upon theory and in the abstract, every one is opposed to grade-crossings; but those most directly concerned always claim that their particular crossing is exceptional in character. In vain do corporations protest and public officials argue; when the concrete case arises all neighborhoods become alike and strenuously insist on their right to incur everlasting danger rather than to have the level of their street broken. During the last seven years to September 30, 1878, 191 persons have been injured, and 98 of them fatally injured, at these crossings in Massachusetts, and it is certain as fate that the number is destined to annually increase. What the result in a remote future will be, it is not now easy to forecast. One thing only would seem certain: the time will come when the two classes of traffic thus recklessly made to cross each other will at many points have to be separated, no matter at what cost to the community which now challenges the danger it will then find itself compelled to avoid.

The heaviest and most regular cause of death and injury involved in the operation of the railroad system yet remains to be referred to; and again it is recklessness which is at the root of it, and this time recklessness in direct violation of law. The railroad

tracks are everywhere favorite promenades, and apparently even resting-places, especially for those who are more or less drunk. In Great Britain physical demolition by a railroad train is also a somewhat favorite method of committing suicide, and that, too, in the most deliberate and cool-blooded manner. Cases have not been uncommon in which persons have been seen to coolly lay themselves down in front of an advancing train, and very neatly effect their own decapitation by placing their necks across the rail. In England alone, during the last seven years, there have been no less than 280 cases of death reported under the head of suicides, or an average of 40 each year, the number in 1878 rising to 60. In America these cases are not returned in a class by themselves. Under the general head of accidents to trespassers, however, that is, accidents to men, women and children, especially the latter, illegally lying, walking, or playing on the tracks or riding upon the cars,—under this head are regularly classified more than one third of all the casualties incident to working the Massachusetts railroads. During the last seven years these have amounted to an aggregate of 724 cases of injury, no less than 494 of which were fatal. Of course, very many other cases of this description, which were not fatal, were never reported. And here again the recklessness of the public has received further illustration, and this time in a very unpleasant way. Certain corporations operating roads terminating in

Boston endeavored at one time to diminish this slaughter by enforcing the laws against walking on railroad tracks. A few trespassers were arrested and fined, and then the resentment of those whose wonted privileges were thus interfered with began to make itself felt. Obstructions were found placed in the way of night trains. The mere attempt to keep people from risking their lives by getting in the way of locomotives placed whole trains full of passengers in imminent jeopardy.

Undoubtedly, however, by far the most effective means of keeping railroad tracks from becoming foot-paths, and thus at once putting an end to the largest item in the grand total of the expenditure of life incident to the operation of railroads, is that secured by the Pennsylvania railroad as an unintentional corollary to its method of ballasting That superb organization, every detail of whose wonderful system is a fit subject for study to all interested in the operation of railroads, has a roadway peculiar to itself. A principal feature in this is a surface of broken stone ballast, covering not only the space between the rails, but also the interval between the tracks as well as the road-bed on the outside of each track for a distance of some three feet. It resembles nothing so much as a newly macadamized highway. That, too, is its permanent condition. To walk on the sharp and uneven edges of this broken stone is possible, with a sufficient expenditure of patience and shoe-leather; but cer-

tainly no human being would ever walk there from preference, or if any other path could be found. Not only is it in itself, as a system of ballasting, looked upon as better than any other, but it confounds the tramp. Its systematic adoption in crowded, suburban neighborhoods would, therefore, answer a double purpose. It would secure to the corporations permanent road-beds exclusively for their own use, and obviate the necessity of arrests or futile threats to enforce the penalties of the law against trespassers. It seems singular that this most obvious and effective way of putting a stop to what is both a nuisance and a danger has not yet been resorted to by men familiar with the use of spikes and broken glass on the tops of fences and walls.

Meanwhile, taken even in its largest aggregate, the loss of life incident to the working of the railroad system is not excessive, nor is it out of proportion to what might reasonably be expected. It is to be constantly borne in mind, not only that the railroad performs a great function in modern life, but that it also and of necessity performs it in a very dangerous way. A practically irresistible force crashing through the busy hive of modern civilization at a wild rate of speed, going hither and thither, across highways and by-ways and along a path which is in itself a thoroughfare,—such an agency cannot be expected to work incessantly and yet never to come in contact with the human frame. Naturally, however, it might be a very car of Jug-

gernaut. Is it so in fact?—To demonstrate that it is not, it is but necessary again to recur to the comparison between the statistics of railroad accidents and those which necessarily occur in the experience of all considerable cities. Take again those of Boston and of the railroad system of Massachusetts. These for the purpose of illustration are as good as any, and in their results would only be confirmed in the experience of Paris as compared with the railroad system of France, or in that of London as compared with the railroad system of Great Britain. During the eight years between September 30, 1870, and September 30, 1878, the entire railroad system of Massachusetts was operated at a cost of 1,165 lives, apart from all cases of injury which did not prove fatal. The returns in this respect also may be accepted as reasonably accurate, as the deaths were all returned, though the cases of merely personal injury probably were not. The annual average was 146 lives. During the ten years, 1868–78, 2,587 cases of death from accidental causes, or 259 a year, were recorded as having taken place in the city of Boston. In other words, the annual average of deaths by accident in the city of Boston alone exceeds that consequent on running all the railroads of the state by eighty per cent. Unless, therefore, the railroad system is to be considered as an exception to all other functions of modern life, and as such is to be expected to do its work without injury to life or limb, this showing does not constitute a very heavy indictment against it.

CHAPTER XXIII.

AMERICAN AS COMPARED WITH FOREIGN RAILROAD ACCIDENTS.

UP to this point, the statistics and experience of Massachusetts only have been referred to. This is owing to the fact that the railroad returns of that state are more carefully prepared and tabulated than are those of any other state, and afford, therefore, more satisfactory data from which to draw conclusions. The territoral area from which the statistics are in this case derived is very limited, and it yet remains to compare the results deduced from them with those derived from the similar experience of other communities. This, however, is not an easy thing to do; and, while it is difficult enough as respects Europe, it is even more difficult as respects America taken as a whole. This last fact is especially unfortunate in view of the circumstance that, in regard to railway accidents, the United States, whether deservedly or not, enjoy a most undesirable reputation. Foreign authorities have a

way of referring to our "well-known national disregard of human life," with a sort of complacency, at once patronizing and contemptuous, which is the reverse of pleasing. Judging by the tone of their comments, the natural inference would be that railroad disasters of the worst description were in America matters of such frequent occurrence as to excite scarcely any remark. As will presently be made very apparent, this impression, for it is only an impression, can, so far as the country as a whole is concerned, neither be proved nor disproved, from the absence of sufficient data from which to argue. As respects Massachusetts, however, and the same statement may perhaps be made of the whole belt of states north of the Potomac and the Ohio, there is no basis for it. There is no reason to suppose that railroad traveling is throughout that region accompanied by any peculiar or unusual degree of danger.

The great difficulty, just referred to, in comparing the results deduced from equally complete statistics of different countries, lies in the variety of the arbitrary rules under which the computations in making them up are effected. As an example in point, take the railroad returns of Great Britain and those of Massachusetts. They are in each case prepared with a great deal of care, and the results deduced from them may fairly be accepted as approximately correct. As respects accidents, the number of cases of death and of personal injury are annually

reported, and with tolerable completness, though in the latter respect there is probably in both cases room for improvement. The whole comparison turns, however, on the way in which the entire number of passengers annually carried is computed. In Great Britain, for instance, in 1878, these were returned, using round numbers only, at 565,000,000, and in Massachusetts at 34,000,000. By dividing these totals by the number of cases of death and injury reported as occurring to passengers from causes beyond their control, we shall arrive apparently at a fair comparative showing as to the relative safety of railroad traveling in the two communities. The result for that particular year would have been that while in Great Britain one passenger in each 23,500, 000 was killed, and one in each 481,600 injured from causes beyond their control, in Massachusetts none were killed and only one in each 14,000,000 was in any way injured. Unfortunately, however, a closer examination reveals a very great error in the computation, affecting every comparative result drawn from it. In the English returns no allowance whatever is made for the very large number of journeys made by season-ticket or commutation passengers, while in Massachusetts, on the contrary, each person of this class enters into the grand total as making two trips each day, 156 trips on each quarterly ticket, and 626 trips on each annual. Now in 1878 more than 418,000 holders of season tickets were returned by the railway com-

panies of Great Britain. How many of these were quarterly and how many were annual travelers, does not appear. If they were all annual travelers, no less than 261,000,000 journeys should be added to the 565,000,000 in the returns, in order to arrive at an equal basis for a comparison between the foreign and the American roads: this method, however, would be manifestly inaccurate, so it only remains, in the absence of all reliable data, and for the purpose of comparison solely, to strike out from the Massachusetts returns the 8,320,727 season-ticket passages, which at once reduces by over 3,000,000 the number of journeys to each case of injury. As season-ticket passengers do travel and are exposed to danger in the same degree as trip-ticket passengers, no result is approximately accurate which leaves them out of the computation. At present, however, the question relates not to the positive danger or safety of traveling by rail, but to its relative danger in different communities.

Allowance for this discrepancy can, however, be made by adding to the English official results an additional nineteen per cent., that, according to the returns of 1877 and 1878, being the proportion of the season-ticket to other passengers on the roads of Great Britain. Taking then the Board of Trade returns for the eight years 1870–7, it will be found that during this period about one passenger in each 14,500,000 carried in that country has been killed in railroad accidents, and about one in each

436,000 injured. This may be assumed as a fair average for purpose of comparison, though it ought to be said that in Great Britain the percentage of casualties to passengers shows a decided tendency to decrease, and during the years 1877–8 the percentages of killed fell from one in 15,000,000 to one in 38,000,000 and those of injured from one in 436,000 to one in 766,000. The aggregates from which these results are deduced are so enormous, rising into the thousands of millions, that a certain degree of reliance can be placed on them. In the case of Massachusetts, however, the entire period during which the statistics are entitled to the slightest weight includes only eight years, 1872–9, and offers an aggregate of but 274,000,000 journeys, or but about forty per cent. of those included in the British returns of the single year 1878. During these years the killed in Massachusetts were one in each 13,000,000 and the injured one in each 1,230,000;—or, while the killed in the two cases were very nearly in the same proportion,—respectively one in 14.5, and one in 13, speaking in millions,—the British injured were really three to one of the Massachusetts.

The equality as respects the killed in this comparison, and the marked discrepancy as respects the injured is calculated at first sight to throw doubts on the fullness of the Massachusetts returns. There seems no good reason why the injured should in the one case be so much more numerous than in the other.

This, however, is susceptible on closer examination of a very simple and satisfactory explanation. In case of accident the danger of sustaining slight personal injury is not so great in Massachusetts as in Great Britain. This is due to the heavier and more solid construction of the American passenger coaches, and their different interior arrangement. This fact, and the real cause of the large number of slightly injured,—"shaken" they call it,—in the English railroad accidents is made very apparent in the following extract from Mr. Calcroft's report for 1877;—

"It is no doubt a fact that collisions and other accidents to railway trains are attended with less serious consequences in proportion to the solidity of construction of passenger carriages. The accomodation and internal arrangements of third-class carriages, however, especially those used in ordinary trains, are defective as regards safety and comfort, as compared with many carriages of the same class on foreign railways. The first-class passenger, except when thrown against his opposite companion, or when some luggage falls upon him, is generally saved from severe contusion by the well-stuffed or padded linings of the carriages; whilst the second-class and third-class passenger is generally thrown with violence against the hard wood-work. If the second and third-class carriages had a high padded back lining, extending above the head of the passenger, it would probably tend to lesson the danger to life and limb which, as the returns of accidents show, passengers in carriages of this class are much exposed to in train accidents." *

* *General Report to the Board of Trade upon the accidents which have occurred on the Railways of the United Kingdom during the year* 1877. *p.* 37.

In 1878 the passenger journeys made in the second and third class carriages of the United Kingdom were thirteen to one of those made in first class carriages;—or, expressed in millions, there were but 41 of the latter to 523 of the former. There can be very little question indeed that if, during the last ten years, thirteen out of fourteen of the passengers on Massachusetts railroads had been carried in narrow compartments with wooden seats and unlined sides the number of those returned as slightly injured in the numerous accidents which occurred would have been at least three-fold larger than it was. If it had not been ten-fold larger it would have been surprising.

The foregoing comparison, relates however, simply to passengers killed in accidents for which they are in no degree responsible. When, however, the question reverts to the general cost in life and limb at which the railroad systems are worked and the railroad traffic is carried on to the entire communities served, the comparison is less favorable to Massachusetts. Taking the eight years of 1871–8, the British returns include 30,641 cases of injury, and 9,113 of death; while those of Massachusetts for the same years included 1,165 deaths, with only 1,044 cases of injury; in the one case a total of 39,745 casualties, as compared with 2,209 in the other. It will, however be noticed that while in the British returns the cases of injury are nearly three-fold those of death, in the Massachusetts returns

the deaths exceed the cases of injury. This fact in the present case cannot but throw grave suspicion on the completeness of the Massachusetts returns. As a matter of practical experience it is well known that cases of injury almost invariably exceed those of death, and the returns in which the disproportion is greatest, if no sufficient explanation presents itself, are probably the most full and reliable. Taking, therefore, the deaths in the two cases as the better basis for comparison, it will be found that the roads of Great Britain in the grand result accomplished seventeen-fold the work of those of Massachusetts with less than eight times as many casualties; had the proportion between the results accomplished and the fatal injuries inflicted been maintained, but 536 deaths instead of 1,165 would have appeared in the Massachusetts returns. The reason of this difference in result is worth looking for, and fortunately the statistical tables are in both cases carried sufficiently into detail to make an analysis possible; and this analysis, when made, seems to indicate very clearly that while, for those directly connected with the railroads, either as passengers or as employés, the Massachusetts system in its working involves relatively a less degree of danger than that of Great Britain, yet for the outside community it involves very much more. Take, for instance, the two heads of accidents at grade-crossings and accidents to trespassers, which have been already referred to. In Great Britain highway grade-crossings are discour-

aged. In Massachusetts they are practically insisted upon. The results of the policy pursued may in each case be read with sufficient distinctness in the bills of mortality. During the years 1872–7, of 1,929 casualties to persons on the railroads of Massachusetts, no less than 200 occurred at highway grade crossings. Had the accidents of this description in Great Britain been equally numerous in proportion to the larger volume of the traffic of that country, they would have resulted in over 3,000 cases of death or personal injury; they did in fact result in 586 such cases. In Massachusetts, again, to walk at will on any part of a railroad track is looked upon as a sort of prescriptive and inalienable right of every member of the community, irrespective of age, sex, color, or previous condition of servitude. Accordingly, during the six years referred to, this right was exercised at the cost of life or limb to 591 persons,—one in four of all the casualties which occurred in connection with the railroad system. In Great Britain the custom of using the tracks of railroads as a foot-path seems to exist, but, so far from being regarded as a right, it is practiced in perpetual terror of the law. Accordingly, instead of some 9,000 cases of death or injury from this cause during these six years, which would have been the proportion under like conditions in Massachusetts, the returns showed only 2,379. These two are among the most constant and fruitful causes of accident in connection with the railroad system

of America. In great Britain their proportion to the whole number of casualties which take place is scarcely a seventh part of what it is in Massachusetts. Here they constitute very nearly fifty per cent. of all the accidents which occur; there they constitute but a little over seven. There is in this comparison a good deal of solid food for legislative thought, if American legislators would but take it in; for this is one matter the public policy in regard to which can only be fixed by law.

When we pass from Great Britain to the continental countries of Europe, the difficulties in the way of any fair comparison of results become greater and greater. The statistics do not enter sufficiently into detail, nor is the basis of computation apparent. It is generally conceded that, where a due degree of caution is exercised by the passenger, railroad traveling in continental countries is attended with a much less degree of danger than in England. When we come to the returns, they hardly bear out this conclusion; at least to the degree commonly supposed. Take France, for example. Nowhere is human life more carefully guarded than in that country; yet their returns show that of 866,000,000 passengers transported on the French railroads during the eleven years 1859–69, no less than 65 were killed and 1,285 injured from causes beyond their control; or one in each 13,000,000 killed as compared with one in 10,700,000 in Great Britain; and one in every

674,000 injured as compared with one in each 330,000 in the other country. During the single year 1859, about 111,000,000 passengers were carried on the French lines, at a general cost to the community of 2,416 casualties, of which 295 were fatal. In Massachusetts, during the four years 1871–74, about 95,000,000 passengers were carried, at a reported cost of 1,158 casualties. This showing might well be considered favorable to Massachusetts did not the single fact that her returns included more than twice as many deaths as the French, with only a quarter as many injuries, make it at once apparent that the statistics were at fault. Under these circumstances comparison could only be made between the numbers of deaths reported; which would indicate that, in proportion to the work done, the railroad operations of Massachusetts involved about twice and a half more cases of injury to life and limb than those of the French service. As respects Great Britain the comparison is much more favorable, the returns showing an almost exactly equal general death-rate in the two countries in proportion to their volumes of traffic; the volume of Great Britain being about four times that of France, while its death-rate by railroad accidents was as 1,100 to 295.

With the exception of Belgium, however, in which country the returns cover only the lines operated by the state, the basis hardly exists for a useful comparison between the dangers of injury from accident

on the continental railroads and on those of Great Britain and America. The several systems are operated on wholly different principles, to meet the needs of communities between whose modes of life and thought little similarity exists. The continental trains are far less crowded than either the English or the American, and, when accidents occur, fewer persons are involved in them. The movement, also, goes on under much stricter regulation and at lower rates of speed, so that there is a grain of truth in the English sarcasm that on a German railway "it almost seems as if beer-drinking at the stations were the principal business, and traveling a mere accessory."

Limiting, therefore, the comparison to the railroads of Great Britain, it remains to be seen whether the evil reputation of the American roads as respects accidents is wholly deserved. Is it indeed true that the danger to a passenger's life and limbs is so much greater in this country than elsewhere?—Locally, and so far as Massachusetts at least is concerned, it certainly is not. How is it with the country taken as a whole?—The lack of all reliable statistics as respects this wide field of inquiry has already been referred to. We have no trustworthy data. We do not know with accuracy even the number of miles of road operated; much less the number of passengers annually carried. As respects accidents, and the deaths and injuries resulting therefrom, some information may be gathered from a careful and very

valuable, because the only, record which has been preserved during the last six years in the columns of the *Railroad Gazette*. It makes, of course, no pretence at either official accuracy or fullness, but it is as complete probably as circumstances will permit of its being made. During the five years 1874–8 there have been included in this record 4,846 accidents, resulting in 1,160 deaths and 4,650 cases of injury;—being an average of 969 accidents a year, resulting in 232 deaths and 930 cases of injury. These it will be remembered are casualties directly resulting either to passengers or employés from train accidents. No account is taken of injuries sustained by employés in the ordinary operation of the roads, or by members of the community not passengers. In Massachusetts the accidents to passengers and employés constitute one-half of the whole, but a very small portion of the injuries reported as sustained by either passengers or employés are the consequence of train accidents,—not one in three in the case of passengers or one in seven in that of employés. In fact, of the 2,350 accidents to persons reported in Massachusetts in the nine years 1870–8, but 271, or less than twelve per cent., belonged to the class alone included in the reports of the *Railroad Gazette*. In England during the four years 1874–7 the proportion was larger, being about twenty-five instead of twelve per cent. For America at large the Massachusetts proportion is undoubtedly the most nearly correct, and the probabilities would

seem to be that the annual average of injuries to persons incident to operating the railroads of the United States is not less than 10,000, of which at least 1,200 are due to train accidents. Of these about two-thirds may be set down as sustained by passengers, or, approximately, 800 a year.

It remains to be ascertained what proportion this number bears to the whole number carried. There are no reliable statistics on this head any more than on the other. Nothing but an approximation of the most general character is possible. The number of passengers annually carried on the roads of a few of the states is reported with more or less accuracy, and averaging these the result would seem to indicate that there are certainly not more than 350,000,000 passengers annually carried on the roads of all the states. There is something barbarous about such an approximation, and it is disgraceful that at this late day we should in America be forced to estimate the passenger movement on our railroads in much the same way that we guess at the population of Africa. Such, however, is the case. We are in in this respect far in the rear of civilized communities. Taking, however, 350,000,000 as a fair approximation to our present annual passenger movement, it will be observed that it is as nearly as may be half that of Great Britain. In Great Britain, in 1878, there were 1,200 injuries to passengers from accidents to trains, and 675 in 1877. The average of the last eight years has been 1,226. If, therefore,

the approximation of 800 a year for America is at all near the truth, the percentage would seem to be considerably larger than that arrived at from the statistics of Great Britain. Meanwhile it is to be noted that while in Great Britain about 25 cases of injury are reported to each one of death, in America but four cases are reported to each death—a discrepancy which is extremely suggestive. Perhaps, however, the most valuable conclusion to be drawn from these figures is that in America we as yet are absolutely without any reliable railroad statistics on this subject at all.

Taken as a whole, however, and under the most favorable showing, it would seem to be a matter of fair inference that the dangers incident to railroad traveling are materially greater in the United States than in any country of Europe. How much greater is a question wholly impossible to answer. So that when a statistical writer undertakes to show, as one eminent European authority has done, that in a given year on the American roads one passenger in every 286,179 was killed, and one in every 90,737 was injured, it is charitable to suppose that in regard to America only is he indebted to his imagination for his figures.

Neither is it possible to analyze with any satisfactory degree of precision the nature of the accidents in the two countries, with a view to drawing inferences from them. Without attempting to do so it may be said that the English Board of Trade re-

ports for the last five years, 1874–8, include inquiries into 755 out of 11,585 accidents, the total number of every description reported as having taken place. Meanwhile the *Railroad Gazette* contains mention of 4,846 reported train accidents which occurred in America during the same five years. Of these accidents, 1,310 in America and 81 in Great Britain were due to causes which were either unexplained or of a miscellaneous character, or are not common to the systems of the two countries. In so far as the remainder admitted of classification, it was somewhat as follows:—

	GREAT BRITAIN.	AMERICA.
Accidents due to		
Defects in permanent way	13 per cent.	24 per cent.
" " rolling-stock	10 " "	8 " "
Misplaced switches	16 " "	14 " "
Collisions		
Between trains going in opposite directions	3 " "	18 " "
Between trains following each other	5 " "	30 " "
At railroad grade crossings*	0.6 " "	3 " "
At junctions	11 " "	
At stations or sidings within fixed stations	40 " "	6
Unexplained		2 " "

* During these five years there were in Great Britain four cases of collision between locomotives or trains at level crossings of one railroad by another; in America there were 79. The probable cause of this discrepancy has already been referred to (*ante pp.* 194–7).

The above record, though almost valueless for any purpose of exact comparison, reveals, it will be noticed, one salient fact. Out of 755 English accidents, no less than 406 came under the head of collisions—whether head collisions, rear collisions, or collisions on sidings or at junctions. In other words, to collisions of some sort between trains were due considerably more than half (54 per cent.) of the accidents which took place in Great Britain, while only 88, or less than 13 per cent. of the whole, were due to derailments from all causes. In America on the other hand, while of the 3,763 accidents recorded, 1,324, or but one-third part (35 per cent.) were due to collisions, no less than 586, or 24 per cent., were classed under the head of derailments, due to defects in the permanent way. During the the six years 1873–8 there were in all 1698 cases of collision of every description between trains reported as occurring in America to 1495 in the United Kingdom; but while in America the derailments amounted to no less than 4016, or more than twice the collisions, in the United Kingdom they were but 817, or a little more than half their number. It has already been noticed that the most disastrous accidents in America are apt to occur on bridges, and Ashtabula and Tariffville at once suggest themselves. This is not the case in Great Britain. Under the heading of "Failures of Tunnels, Bridges, Viaducts or Culverts," there were returned in that country during the six years 1873–8

only 29 accidents in all; while during the same time in America, under the heads of broken bridges or tressels and open draws, the *Gazette* recorded no less than 165. These figures curiously illustrate the different manner in which the railroads of the two countries have been constructed, and the different circumstances under which they are operated. The English collisions are distinctly traceable to constant overcrowding; the American derailments and bridge accidents to inferior construction of our roadbeds.

Finally, what of late years has been done to diminish the dangers of the rail?—What more can be done?—Few persons realize what a tremendous pressure in this respect is constantly bearing down upon those whose business it is to operate railroads. A great accident is not only a terrible blow to the pride and prestige of a corporation, not only does it practically ruin the unfortunate officials involved in it, but it entails also portentous financial consequences. Juries proverbially have little mercy for railroad corporations, and, when a disaster comes, these have practically no choice but to follow the scriptural injunction to settle with their adversaries quickly. The Revere catastrophe, for instance, cost the railroad company liable on account of it over half a million of dollars; the Ashtabula accident over $600,000; the Wollaston over $300,000. A few years ago in England a jury awarded a sum of $65,000 for damages sustained through the death of a single in-

dividual. During the five years, 1867–71, the railroad corporations of Great Britain paid out over $11,000,000 in compensation for damages occasioned by accidents. In view, merely, of such money consequences of disaster, it would be most unnatural did not each new accident lead to the adoption of better appliances to prevent its recurrence.*

To return, however, to the subject of railroad accidents, and the final conclusion to be drawn from the statistics which have been presented. That conclusion briefly stated is that the charges of recklessness and indifference so generally and so widely advanced against those managing the railroads cannot for an instant be sustained. After all, as was said in the beginning of the present volume, it is not the danger but the safety of the railroad which should excite our special wonder. If any

* The other side of this proposition has been argued with much force by Mr. William Galt in his report as one of the Royal Commission of 1874 on Railway Accidents. Mr. Galt's individual report bears date February 5, 1877, and in it he asserts that, as a matter of actual experience, the principle of self-interest on the part of the railway companies has proved a wholly insufficient safeguard against accidents. However it may be in theory, he contends that, taking into consideration the great cost of the appliances necessary to insure safety to the public on the one side, and the amount of damages incident to a certain degree of risk on the other side, the possible saving in expenditure to the companies by assuming the risk far exceeds the loss incurred by an occasional accident. The companies become, in a word, insurers of their passengers,—the premium being found in the economies effected by not adopting improved appliances of recognized value, and the losses being the damages incurred in case of accident. He treats the whole subject at great length and with much knowledge and ability. His report is a most valuable compendium for those who are in favor of a closer government supervision over railroads as a means of securing an increased safety from accident.

one doubts this, it is very easy to satisfy himself of the fact,—that is, if by nature he is gifted with the slightest spark of imagination. It is but necessary to stand once on the platform of a way-station and to look at an express train dashing by. There are few sights finer; few better calculated to quicken the pulse. It is most striking at night. The glare of the head-light, the rush and throb of the locomotive,—the connecting rod and driving-wheels of which seem instinct with nervous life,—the flashing lamps in the cars, and the final whirl of dust in which the red tail-lights vanish almost as soon as they are seen,—all this is well calculated to excite our admiration; but the special and unending cause for wonder is how, in case of accident, anything whatever is left of the train. As it plunges into the darkness it would seem to be inevitable that something must happen, and that, whatever happens, it must necessarily involve both the train and every one in it in utter and irremediable destruction. Here is a body weighing in the neighborhood of two hundred tons, moving over the face of the earth at a speed of sixty feet a second and held to its course only by two slender lines of iron rails;—and yet it is safe!—We have seen how when, half a century ago, the possibility of something remotely like this was first discussed, a writer in the *British Quarterly* earned for himself a lasting fame by using the expression that "We should as soon expect people to suffer themselves

to be fired off upon one of Congreve's *ricochet* rockets, as to trust themselves to the mercy of such a machine, going at such a rate ;"—while Lord Brougham exclaimed that "the folly of seven hundred people going fifteen miles an hour, in six trains, exceeds belief." At the time they wrote, the chances were ninety-nine in a hundred that both reviewer and correspondent were right; and yet, because reality, not for the first nor the last time, saw fit to outstrip the wildest flights of immagination, the former at least blundered, by being prudent, into an immortality of ridicule. The thing, however, is still none the less a miracle because it is with us matter of daily observation. That, indeed, is the most miraculous part of it. At all hours of the day and of the night, during every season of the year, this movement is going on. It never wholly stops. It depends for its even action on every conceivable contingency, from the disciplined vigilance of thousands of employés to the condition of the atmosphere, the heat of an axle, or the strength of a nail. The vast machine is in constant motion, and the derangement of a single one of a myriad of conditions may at any moment occasion one of those inequalities of movement which are known as accidents. Yet at the end of the year, of the hundreds of millions of passengers fewer have lost their lives through these accidents than have been murdered in cold blood. Not without reason, therefore, has it been asserted that, viewing at

once the speed, the certainty, and the safety with which the intricate movement of modern life is carried on, there is no more creditable monument to human care, human skill, and human foresight than the statistics of railroad accidents.

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